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SOME DYNAMO-ELECTRIC MACHINES.

So far as we can judge from the published reports of Professor Rowland's paper on "The Theory of the Dynamo-Electric Machine," read before the Philadelphia Congress of Electricians, we cannot see that he has added much, if anything, to the knowledge which electricians, at least in this country, had already gained. The paper, indeed, which seems to have been hastily compiled, is vague and somewhat unintelligible, as if the author had but a confused notion of what he wished to bring before the meeting. The discussion, however, in which Professor Silvanus Thompson took a prominent part, in a way which redounds greatly to his credit, was much more vigorous, and we can promise our readers something (in due course) well worth their perusal.

We notice that Professor Rowland expressed himself to the effect that the inner portion of the wire on a Gramme ring is useless. That this is not strictly the case will, we think, be readily admitted; but cannot someone devise a simple experiment, appealing to the perceptive faculties of all, to show to what extent the inner wire is active? This would be rendering a real service to electricians, in whose minds these doubts should not be allowed to remain.

Another machine which the Professor criticised rather severely, and one with which he was evidently not familiar, judging from the description and diagram, was that of Ball, the so-called "Unipolar." Professor Silvanus Thompson also passed comments the reverse of favourable upon this unfortunate dynamo, which appears fated to be looked upon as something quite uncanny. Yet the suspicions which cross the minds of both American and English electricians concerning this machine can only be due to its peculiar construction—they are certainly not based upon its performances. The "lines of force" theory does not, as Professor Rowland admitted, fit itself readily to this apparatus: and so without any further explanation the Ball machine is shelved. Our readers will remember the tests made in 1883 upon a Ball dynamo by the late Mr. Robert Sabine, and also others at the beginning of this year upon a later form of machine, which more than bore out the figures of the high efficiency obtained with the first. Perhaps the remarks of Prof. Nipher on this subject are more sensible and reasonable than those of any other scientist who took part in the discussion. This gentleman said: "It occurs to me to say a few words in regard to an unfortunate machine which has been referred to several times, and which I saw the other day for the first time. It has two armatures and only two pole pieces. I was as much astonished as anybody could be when I saw it; but when I was informed that it weighed less than 1,000 lbs. and maintained a high strength of current, I thought it worth while to investigate what the machine would do before we said too much about how it worked."

If we are not mistaken, one eminent Professor alluded to the Hochhausen machine last year as being both mechanically and electrically bad; and quite as eminent an electrician declared it to be—we believe at the same meeting—the most wonderful dynamo he had seen.

These discussions on theoretical points are very well in their way; but no man has a right to condemn a machine which to him seems at variance with his pet theory, unless, indeed, such an apparatus is palpably a fraud to the whole recognised scientific world. The best way of arriving at the comparative merits of the machines discussed in the Congress of Electricians at Philadelphia, will be to form a judgment from the reports of the examining committee, if time and other considerations allow the proposed tests to be properly carried out.

A NEW FORM OF THE BUNSEN PHOTOMETER.

By DR. HUGO KRÜSS.

BUNSEN'S oil-spot photometer is the most generally employed of all instruments for the measurement of light. As far back as 1843, when W. Th. Casselmann described this apparatus in detail for the first time, he proved experimentally that Bunsen's photometer admits of results considerably more accurate than the photometers of Rumford and Ritchie. Rumford's shadow photometer is no longer used for exact measurements on account of its great inaccuracy, and of that class of instruments which are derived from Bouguer's principle the only one to be considered is that of Foucault, which is extensively used in France.

Bunsen's photometer has hitherto met with far more general application in the gas manufacture than that of Foucault, and in electrotechnics also the Bunsen photometer is used in most cases. This preference is due to the reason, advanced by Casselmann as an advantage of this principle, that a difference in the colour of the two sources of light to be compared with each other is here far less detrimental.

The chief difficulty in the determination of the brightness of powerful arc lamps springs from the difference in colour of the electric light and of the gas, petroleum, or oil flame taken as a standard for comparison. The two surfaces of the photometer, whose brightness has to be compared, are coloured very differently by the two sources of light. Nearly all observers who use the Foucault photometer affirm that this unequal colouration of the two halves of the screen has a very disturbing influence in measuring the intensity of the electric light. If this is much less the case with the Bunsen photometer the reason is that it does not only depend on a comparison of the intensity of two surfaces illuminated by the two sources of light, but that we have a further gauge for the correct placement of the screen by attending to the equal distinctness of the margins of the oil spot against the unoiled paper on both sides of the screen.

Thus in working with the Bunsen photometer it is possible, after sufficient experience, entirely to overlook the different impressions of colour on the two illuminated sides, and by observing the margins indicated to obtain more accurate results than with the Foucault photometer, in spite of the different colourations.

This advantage seems to me decisive in the selection of a photometer. Still, the Bunsen instrument, notwithstanding various proposed modifications, suffers from a very palpable defect, which in many cases occasions Foucault's instrument to be preferred. In the latter the two illuminated surfaces to be compared with each other meet in a sharp line, whilst in Bunsen's photometer the result depends on the comparison of the two sides of one and the same paper screen. In all the arrangements based upon Bunsen's principle, one difficulty or inconvenience is always encountered. I, therefore, venture to point out a new method for reaching the object which may prove useful, though I do not deny the possibility of a still better solution of the question.

The construction of the Bunsen photometer depends on the circumstance that an oil spot upon paper, if seen by transmitted light, appears light on a dark ground, whilst by reflected light it is dark on a light ground. Hence we might infer that if the paper were illuminated equally strongly on both sides, the spot would appear neither light on a dark ground nor dark on a light ground, but would entirely disappear.

This would be in fact the case if the light falling upon the paper screen were resolved into two parts only—the one reflected and the other transmitted. If the screen is placed exactly in the middle between two sources of light of exactly equal intensity, observation shows that the oil spot does not disappear, but appears dark on a light ground. The incident light is resolved not into two but three parts, the third part being absorbed both by the oiled and the unoiled paper, but in a different proportion.

Thus there are to be noted three positions of the photometer screen—that in which the oil spot disappears to the right, that in which it disappears to the left, and that in which it is equally distinguishable from the unoiled paper on both sides. Mathematical investigation shows that from the mean position the correct proportion of the intensity of the two sources of light can be directly found according to the law of the decrease of brightness as the square of the distance. It may also be calculated from the geometrical mean of those relations of intensity corresponding to the two positions in which the oil spot disappears to the left and the right.

In the modification of the Bunsen photometer proposed by Desaga, and formerly much in use, only one of these three positions is employed, that, namely, in which the oil spot disappears on one side of the screen. If we call this side the front, a small gas flame is placed as an auxiliary source at a constant distance behind the screen, and is movable with it. The front of the screen is then turned successively to the two sources of light which are to be compared with each other, and brought each time to such a distance that the oil spot disappears.

This arrangement is applicable in the gas-manufacture where the sources of light differ little from each other, and are approximately alike in colour. In electro-technics it is inapplicable since sources of light have often to be compared which cannot be displaced with the paper screen, and, further, because the differences of colour are so great that the oil spot does not disappear at all. Work with this photometer is made more difficult by the necessity for employing an auxiliary light, which must be carefully kept constant.

The same objections must be raised against Zenger's differential photometer—a very fascinating instrument theoretically speaking. The paper screen is here fixed in the median line of a right angle formed by the two graduated rods on which the sources of light are moved. Here is the further difficulty that the sources of light which are to be measured have to be moved towards the screen in order to get the right distance. With many sources of light, especially electric arc lamps, this is impracticable. Besides, there would be required either an assistant or a complicated and consequently costly mechanical arrangement.

Rudorf's modification of Bunsen's photometer has been most extensively adopted. Here (fig. 1) the screen, P, with the oil spot, F, is placed in the median line of an angle of 140° formed by the two mirrors, S_1 and S_2. The observing eye, A, sees the images of both sides of the screen simultaneously in the two mirrors, S_1 and S_2, and can compare their respective intensity.

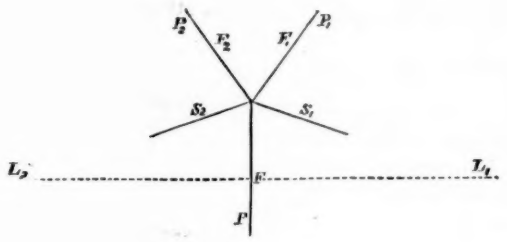

FIG. 1.

In this arrangement there is almost exclusively used that position only of the screen between the two sources of light, L_1 and L_2, in which the screen is equally illuminated on both sides, and in which, therefore, the images, F_1 and F_2, of the oil spot, F, appear equally dark on a light ground. The question may then be raised why, as the criterion of the complete disappearance of the oil spot is not used, this spot is not omitted and the Foucault photometer employed? The answer has been given above in the explanation how an increase of accuracy is obtained by observing the margins of the spot.

This modification of Rudorf's, with all its advantages, has two defects. If the distance from the source of light to the screen is not very large in proportion to the dimensions of the latter, the rays do not impinge approximately vertically upon all parts of the screen, and the illumination of the whole surface is not equal. A consequence is that the position of the screen is different as soon as the eye is turned a little out of the median line towards one side. The correct direction of the eye might, of course, be secured by looking through a stop with a moderately small aperture.

The second, and much more important defect, is that the two images F_1 and F_2 to be compared, lie at a great distance from each other. This defect is unavoidable, since, in consequence of the shadows which the mirrors throw upon the screen, the oil spot must be at a considerable distance from the apex of their planes. Even though a tolerable exactitude in observation may be attained by experience, the necessity of comparing two surfaces at a distance from each other is often a reason which deters observers from the use of the Bunsen photometer and leads them to prefer Foucault's instrument.

Some time ago I sought for and found a means of combining the great advantage of the Bunsen photometer, the use of the oil spot, with the advantage of Foucault's apparatus, the comparison of two surfaces in immediate contact with each other. Recently Hefner-Alteneck has made public a contrivance to the same end; this induced me to have my idea carried out and introduced in technical circles.

Hefner-Alteneck substitutes for the two mirrors placed behind the screen two prisms applied in front of the screen. An eye before them can thus perceive simultaneously both sides of the screen by means of refraction. The injurious space in the shadow of the two mirrors is thus avoided, the paper screen can be used immediately at the end of the line in which the two prisms meet, and the two illuminated fields, or their images, come thus in direct contact. In the figure with which Hefner-Alteneck illustrates his device, the optical axis of the photometer, certainly does not pass through the terminal point in question, but this would be easily effected by a displacement of the prisms.

An essential defect of Hefner-Alteneck's modifi-

cation is, that the images of both sides of the screen are produced by refraction in a prism. In consequence, the images appear somewhat distorted and there arises a chromatic dispersion producing distinctly coloured margins even with the angle of the prism of near 30°, as shown in the figure. A very small angle can scarcely be selected, as the images then would be too little inclined towards each other and would consequently be difficult to observe.

In my arrangement I make, therefore, exclusive use of prisms, applying two reflection prisms, I and II. In the prolongation of the median plane in which the two prisms meet stands the screen, P. The angles formed by the planes of the prisms with each other are so selected that the rays which from all points of the screen between *a* and *b* fall vertically upon the plane, A_1, of the prism, I, are reflected at B_1, C_1, and A_1, and then issue out of the prism vertically to the plane, D_1. Similar is the course of the rays in the second prism, II. In front of the planes, D_1 and D_2, which

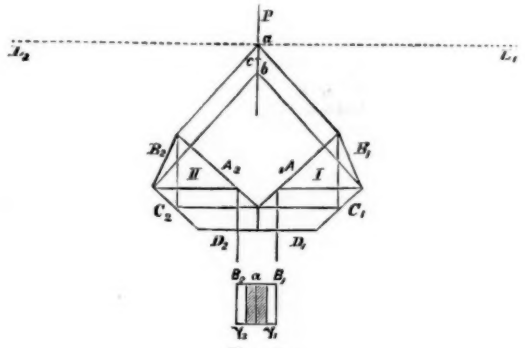

FIG. 2.

meet at an acute angle, a tube can be applied of a length which can be varied according to the sight of the observer. At its end is a diaphragm with a small aperture by which the position of the observing eye is fixed in the plane of the screen.

The eye then sees the field divided into two equal parts by the line, *a*, separating the two planes, D_1 and D_2; the right side is the image of the right side of the screen illuminated by the source of light, L_1; the left half is that of the left side of the screen illuminated by the second source of light, L_2. The image of *a* falls in the median line, *a*, and the images of *b* in the lateral margins of the field of vision, β_1 and β_2.

If the optical axis of the photometer is laid through the point, *a*, perpendicularly to the plane of the screen, and if the portion of the screen from *a* to *c* is oiled, γ_1 and γ_2 are the images of the margins of the oil spot. On both sides of the median line, *a*, if the photometer is set accurately, the illumination is perfectly equal, and this position is very convenient, as the surfaces to be compared are in immediate contact.

Experiments with this photometer have given very accurate results. By using a screen without the oil spot, or by displacing the screen so that the spot falls outside the effective space, *a*, *b*, the apparatus can be easily converted into a Foucault photometer, and the observer can convince himself that this apparatus gives decidedly less accurate results than Bunsen's oil-spot photometer.—*Repertorium der Physik.*

THE DISTRIBUTION OF ELECTRICAL ENERGY.

M. GAULARD, writing from the Turin Exhibition on the 15th October, sends the following communication to the editor of *La Lumière Electrique*:—"In the number of *La Lumière Electrique* for October 11th, you published a communication from Prof. Colombo on the experiments made at the Turin International Exhibition of Electricity by means of the secondary generators of Gaulard and Gibbs. This communication was preceded by an article in which M. Marcel Deprez seeks to show that the invention is not novel, that it has no scientific value, and that from an industrial point of view it is not patentable; and, in fine, that it is not susceptible of any useful application.

"Being directly concerned as the inventor of the system of the distribution of electric energy, which is the subject of this article, I think I may claim from your courtesy the insertion of the following rectification.

"In reply to the first point, I must remind M. Marcel Deprez that Prof. Colombo's communication contains literally the following sentence:—'These apparatus are composed in principle of two helices, formed very ingeniously of discs of copper superimposed on and insulated from each other, the discs or spirals of one helix comprising between them those of the other.'

"Now I do not believe that the earlier researches of M. Marcel Deprez, Sir C. Bright, and M. Jablochkoff, on the phenomena of induction effected by means of Ruhmkorff's coils, can be confounded with those undertaken by means of the instrument above described, and which differs from Ruhmkorff's coil, not merely in its form, but in the fundamental principle of its construction, which I have claimed a long time ago, and which consists in the absolute necessity of the equality of the inducing and induced masses, and the symmetry of their position with respect to the magnetic field, in order to obtain the maximum yield in the recovery of the transformed energy.

"Therefore, until M. Marcel Deprez shall have demonstrated that an apparatus similar in form and principle has been constructed by himself or by others, I shall consider myself as the inventor of a new arrangement, both from a scientific and an industrial point of view.

"As regards the novelty of the results, the controversies carried on to the present day on the yield of secondary generators prove that our predecessors have never even conceived the possibility of obtaining them.

"Measurements, which I consider as exact, have been taken at the Turin Exhibition by the members of the international jury by a method, the defence of which I leave to MM. Joubert and Mascart, since an instrument invented by the latter of these *savants* was used in these determinations.

"These measurements establish that the apparatus which we submitted to the examination of the jury furnish, when employed to produce the work for which they were constructed, a yield of 89 to 90 per cent. The apparatus measured by MM. Joubert and Pottier was represented by us as furnishing an electric work of 2-horse power, or 1,492 watts, under the influence of a primary current of 12 ampères. This apparatus, composed of 1,000 copper discs, of 12 centimetres external diameter, with a space of 5 centimetres in the centre, and of ½ millimetre in thickness, forms a column of 15 centimetres in diameter, and 55 centimetres in height.

"The weight of the copper employed is 20 kilos., and the price, consequently, is 60 francs. M. Marcel Deprez has, therefore, misinterpreted the communication of Prof. Colombo when he affirms that the mere price of the copper used in the construction of our apparatus amounts to 17 francs per Edison lamp, since with 60 francs worth of copper we construct an apparatus capable of supplying 18 to 20 16-candle lamps. Thus, though M. Marcel Deprez pretends that it will be easy to find varied arrangements answering the same end, and which are certainly public property, I still doubt whether, in spite of his inventive genius, he will be able for a long time to find a more economic arrangement.

"There only remains the question whether our apparatus are capable of rendering industrial service. But all along, or at least since the learned researches of M. Marcel Deprez and his predecessors have given a powerful impulse to the utilisation of the phenomena which electricity is capable of producing, the great concern of electricians has been to find industrial means of distributing electric energy. Without criticising here researches previously undertaken in this direction, we can say that no practical result has been secured in competition with that given by our secondary generator. I do not require to tell M. Marcel Deprez that one of the essential conditions for transmitting energy to a great distance is to give to the work transmitted the form of small quantity and high tension. But as, on the other hand, we do not know of any other instrument capable of utilising industrially this form of energy, save the machine which he has promised to construct, we thought that it would be simpler, more logical, and consequently more useful, to search out the conditions of the industrial establishment of apparatus capable of transforming energy transmitted to a great distance, so as to render it utilisable by all apparatus, lamps, and machines which modern industry has at its disposal.

"M. Marcel Deprez urges as an objection against us the necessity of employing for the working of our system for the distribution of energy, alternating current, which he pronounces dangerous. Not only is it possible for us to use currents of a uniform direction if they are interrupted or undulated, but we have good reasons for giving the preference to alternating currents. The first is that the principal circuit supplying all the secondary generators is closed metallically at the limits of the generator, whence it results that the points of the circuit which might be touched by consumers cannot have, at most, a difference of more than 100 volts, which is far from being formidable. On the other hand I do not believe that the system of the transmission of energy by means of continuous currents, such as M. Marcel Deprez proposes to establish offers a greater security. But the principal reason which leads us to adopt the alternative form for our primary currents is the simplicity with which great work may be

obtained by means of known types of machines with alternating currents, whilst it seems to me very difficult, in default of proof to the contrary, to place upon dynamo machines with continuous currents, collectors capable of gathering great electromotive forces. Lastly, as to the independence of the apparatus it is absolute on our system. It is incorrect to say that the working of the lamps fed by our generators is compromised by the extinction of a single lamp, or of several, for the mobility of the magnetic field of our apparatus enables us, on the contrary, to vary at will the intensity of the current developed in their secondary circuit.

"As for the reproach urged against us that we can distribute merely light, if it were merited, still the fact of being able to utilise natural forces at distance for lighting up towns might satisfy the most impatient. But the difficulty signalised of producing an economic motor, by means of alternating currents, does not alarm us. If, for the production of motive power and for electro-chemical work, it is useful to have continuous currents, we shall effect on the secondary generators the same rectification of the current, as it has to be done with ordinary dynamos. It will be easy for us to supply to all kinds of machines the form of energy most suitable for their action, so that we have solved by the simplest method, not merely the question of the transmission of power to a distance, but the much more important problem of its distribution. But for the present we will simply claim the facts established, and for which our priority cannot be called in question.

"The experiments at Lanzo have taken place, not merely in presence of the jury, but have been repeated with complete success before the Italian Minister of Public Works and more than 300 Italian engineers and architects assembled at Turin by occasion of the fifth Congress.

"For five consecutive hours, the stations of Turin, Venario and Lanzo, connected with the gallery of the Exhibition by means of a circuit of 80 kilometers of chrome bronze wire, 3·7 millimetres in diameter, having a conductivity of 98 per cent., and courteously placed at our disposal by the firm Mouchel, have been lighted up as follows:

"The station of Turin with 34 16-candle Edison lamps, 48 8-candle lamps and one Siemens lamp; the station of Venario by two Siemens arc lamps; the station of Lanzo with nine Bernstein lamps, 16 Swan lamps of 100 volts, one sun-light and two Siemens arc lights. At the Exhibition there were burning nine Bernstein lamps, nine Swan lamps and one sun lamp, and in the Figaro kiosk, served by a small type secondary generator, five Swan lamps.

"In face of these results the jury awarded to MM. Gaulard and Gibbs the grand prize of 10,000 francs, given by the Italian Government. In spite of our invitation of January last, M. Marcel Deprez had the kindness not to come and contest it with us. Further, the fifth section of the Congress of Italian Engineers and Architects closed its works with the following order of the day:

"'The fifth section of the fifth Congress of Italian Engineers and Architects assembled at Turin in 1884, cannot overlook the great importance of the experiments on the transmission of electric energy to great distances, conducted at Turin by means of the secondary generators of Gaulard and Gibbs, and having been able to appreciate the working of this system of distribution expresses the wish:

"'That government, municipal bodies and manufacturers may support the establishment of this system, and that the hopes may be realised which six months' experience on the metropolitan railway of London, the experiments at Turin-Lanzo, and the sound conceptions on which this system is based, have excited in the scientific and industrial world.'

"The sole conclusion to be drawn from these facts is that the distance from Paris to Turin is too great to permit M. Marcel Deprez to judge the case with a full knowledge of the circumstances. But the illumination of the stations on the railway Torino-Cirié-Lanzo will be continued until the close of the Exhibition, and the quarantine being now suppressed, the difficulty in the way of a full examination by those interested is considerably diminished.

"However this may be, it is with a legitimate satisfaction that in the midst of the wonderful signs of the development of Italian industry, of which Turin is at present the theatre, I have kept the flag of France at the head of the progress realised by the applications of science to industry."

THE ELECTRIC LIGHT ON THE INDIAN TROOPSHIPS.

IT is stated that the six hours' official trials which took place on Monday and Tuesday last week on board H.M.S. *Euphrates* mark the completion of the contract which was given to the Edison and Swan United Electric Light Company, Limited, for the lighting of the whole of the Indian Government troopers by the Edison system.

Commencing in May of last year, the company has, says the Portsmouth *Evening News* of the 30th ultimo, during the usual period which elapses between the termination of one trooping season and the commencement of the next, fitted the *Malabar*, *Crocodile*, *Serapis*, *Jumna*, and now the *Euphrates*, in the order enumerated, with Edison incandescent electric lamps from bow to stern, and almost from truck to keelson. The following table will doubtless prove interesting:—

Name of Ship.	No. of lamps.*		Dynamos.	Engines.	Speed.
	Full.	Half.			
Malabar	115	264	2 Edison	2 Brotherhood (3 cylinder)	525
Crocodile ...	98	288	2 Edison-Hopkinson	Do.	450
Serapis	101	300	Do.	2 Gwynne Invincible	450
Jumna	97	300	2 Edison improved	2 Brotherhood	280
Euphrates ...	98	301	Do.	Do.	280

Note.—Full lamps are of 16 candle-power; half lamps are of eight candle-power on the *Malabar*, and 10 candle-power on the remainder.

In addition to the above there are on each ship two large reflectors, each containing eight 50-candle lamps, which are intended to be slung to the yard-arms for the purpose of facilitating the operations of coaling ship, embarkation and debarkation of troops, &c., and are also found to furnish a charming illumination for the impromptu concerts and dances with which the ladies and officers relieve the monotony of their passage to India or home. The *Crocodile* is in addition fitted with mast-head and port and starboard lights of 50 candles.

No better instance could be quoted of the vast strides towards perfection which electric ship lighting has taken during the past 18 months than these admirable installations. Starting with the *Malabar*, the electric machinery of which runs at 525 revolutions per minute, whilst each dynamo is capable of sustaining but 150 full lamps, the speed has progressively been reduced to 450 on the *Crocodile* and *Serapis*, and 280 on the *Jumna* and *Euphrates*, whilst one dynamo is now capable of sustaining the whole of the lamps in each of the four latter ships, thus allowing the other machine to be held in readiness in case of any accident; indeed, on the *Jumna* and *Euphrates*, one machine is found amply sufficient to keep the two yard-arm reflectors going, in addition to the total lighting of the ship.

Again, owing to the lesser electromotive force required on the eight-candle lamps of the *Malabar*, it is there impossible to substitute full for half lamps, or *vice versâ*, whilst on the remainder all lamps take equal electromotive force, and it is therefore practicable to change the amount of light at any particular spot to suit the convenience or necessity of the occasion. The great advantage of being able to more than treble the lighting of the engine-room, for instance, in the event of a break-down occurring, is a boon which cannot be over estimated.

Another improvement over the first installation has been effected in the remainder by placing the lights in each cabin instead of in the pilastres, and we understand that it is contemplated to make this alteration, together with the substitution of half lamps of equal electromotive force to the full ones, on the *Malabar* at the termination of the present season. The saloons, engine and boiler rooms, are lighted with full lamps on all ships, whilst each cabin and mess table has a half lamp allotted to it. In each cabin there is a small switch, controlling its lamp, so that the occupants can obtain light at any moment during the night, or extinguish it at pleasure, whilst the mess table lights are controlled in groups, thus enabling the "lights out" rules of the Service to be complied with, a certain number of lamps remaining alight throughout the night as police lamps.

* [The figures in the above table, it will be noted, are in one or two instances different from those given in the table reprinted from the *Times* a week or so ago.—EDS. ELEC. REV.]

Considerable improvements have been likewise effected in the wood casing, which covers the wires, which now appear able to stand not only the most severe deck washing, so dear to the heart of a blue-jacket, but also the intense heat of the stokehole.

A noticeable feature is the complete safeguard against fire by damage to the electric wires, which is attained by the insertion of a short piece of lead wire in the circuit of each individual lamp and main group of lamps, which is calculated to fuse long before, through any cause, a dangerous elevation of temperature can be set up in the wires.

In the direction of cost the superiority of electric light has proved most marked: for with a vastly increased amount of light the cost of the purser's dip has been beaten by 50 per cent., actual trial having proved that where considerably over £200 was expended on oil and candles, the electric light has cost but little over £100 to maintain, the item of renewal of lamps through failure of the carbon loops having proved exceptionally small; an average life of 4,000 to 5,000 hours actual burning having been attained through the care in manufacture taken by the company, and the rigid tests for the detection of faulty lamps which they make before issue from their factories, in which the immense number of 6,000 to 8,000 per week are produced. The whole of the work has been carried out to the complete satisfaction of the Dockyard officials—who have closely scrutinised it during its progress, and severely tested each ship as completed—by Mr. Douglas C. Bate, A.S.T.E. & E., assistant engineer of the contracting company.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—MONTREAL, 1884.

ON THE SEAT OF THE ELECTROMOTIVE FORCE IN THE VOLTAIC CELL.

By Prof. OLIVER J. LODGE.

(Specially reported for the "Electrical Review.")

Read before the British Association at Montreal, in Section A, August 29th, 1884.

[PRELIMINARY NOTES.—A copy of these Notes, which were placed in the hands of each member present at the commencement of the reading, has already appeared in our columns, see page 261, ELECTRICAL REVIEW, October 4th.]

As this is the first formal discussion ever held in Section A, I may be permitted, in starting, to say with what hope I look forward to these discussions in the future, and how anxious I am that they should succeed. I have attended the meetings of the British Association consecutively for 12 years, and I have been more and more impressed with the small result that the sectional meetings have as compared with what might be expected, considering the magnitude of the men who frequently take part in them. In this section room physicists from all parts of the British Isles, as well as from Europe and America, are more frequently to be met with than at the meetings of the Royal Society itself, and the whole atmosphere ought to be favourable to a free and informal interchange of opinions most beneficial, instructive, and stimulating to the younger men, like myself, and to a great extent this is the case, especially when our present president is at the meetings, whether in the chair or out of it. But still, as a rule, there is a long list of papers to be gone through every day, the discussion on each being nipped in the bud in order to get on to the next and clear off the list. In favour of this practice of encouraging papers rather than discussions, it may be truly urged that useful discussions on abstruse papers, such as we are likely to have in this section, are almost impossible. Only in case one has been recently working at a similar subject does the ordinary physicist feel competent even to ask a pertinent question. Now it seems to me that abstruse papers, or papers on out of the way, and to most persons uninteresting, topics, rather should be communicated to one of the many learned societies whose business is with papers and their publication; and that communications to this meeting ought primarily to be on discussable topics, whether these be rigorously new or not; and if papers on fundamental and well known topics, concerning which there was still outstanding differences of opinion, if such papers were encouraged and definitely asked for in good time beforehand, workers might be encouraged to look up that particular subject specially, to read its literature, may be to make experiments in it, and generally to give it that careful thought without which discussions can neither be lively nor fruitful. It was with these ideas that the secretaries of the section last year agitated for the inauguration of such discussions, and, thanks to the energy of Dr. MacAlister, they now begin at this unique and most interesting meeting.

The subject chosen for the present discussion illustrates in a remarkable way the need for such conversation. It is scarcely credible, at the present rate of progress, that 84 years after the discovery of the voltaic pile opinions should still be utterly divided as to the seat of the E.M.F. in it. I venture to hope that it may now be decided, and a substantial agreement arrived at with respect to it. My business is to open the discussion, but it so happens that for some seven or eight years I have believed myself to see more or less clearly to the root of this particular matter, and a laborious review of the literature of the subject has only strengthened my conviction. Having, therefore, strong and definite views, I can hardly help letting them appear, and without assuming that these views are agreed with primarily, or even at all, they may yet serve as a link with which to connect the facts and the multifarious observations thereon.

In the course of my reading on the subject I have found only two great epoch-making papers—that of Volta in 1801, and that of Sir William Thomson in 1851. The other contributions are some of them keen, like those of Faraday, and of Pellat. Some of them are laborious, like Hankel's and Ayrton and Perry's; but none contain anything specially and powerfully new, except those two: unless, indeed, we include in the subject the immensely important phenomena of Seebeck and of Peltier, and Faraday's fundamental law of electro chemical decomposition. Volta showed that when two metals were put into contact and separated, the insulated one was charged with electricity sufficient to make gold leaves diverge. He also stated that the contact force between any two metals was independent of intermediate metals, so that the metals could be arranged in a definite numerical series; and he gave the first series of the kind—

$$\underbrace{Zu - Th}_{5} \quad \underbrace{- SM}_{1} \quad \underbrace{- Fc}_{1} \quad \underbrace{- Cu}_{2} \quad \underbrace{- AG}_{3}$$

Moreover, he started a hypothesis to account for the action, a sort of impulsion or attraction of electricity by matter, an idea subsequently elaborated by Helmholtz. Fabroni objected to Volta's explanation of his experiment. He denied contact force, and considered that electricity was developed by chemical action. Then the fight began, and lasted on and off some half century. On the one side were Volta, Davy, Pfaff, Peclet, Mariani, Buff, Fechner, Zamboni, Matteuci, Kohlrausch. On the other were Fabroni, Wollaston, Parrot, Oersted, Ritchie, Pouillet, Schoenbein, Becquerel, De la Rive, and Faraday.

It was not all fighting. Part of it resulted in a more thorough investigation of the voltaic phenomena, and very often the original point of dispute was lost sight of, and Volta's fact itself was doubted in the eagerness to disprove Volta's explanation. Pfaff's and Peclet's, and other experiments fairly well established the correctness of his observations, and Kohlrausch invented a condenser method of measuring the voltaic force absolutely, which has been employed with modifications by Hankel, by Gerland, by Clifton, by Ayrton and Perry, by Von Zahn and by most other experimenters on the subject. Wherever electrostatic methods were employed, and when the electroscope was the instrument of research, the contact theorists had it all their own way, and it was only by apparent efforts and twisting of experiments that the chemical theorists could maintain their ground, but when electric currents were dealt with and the galvanometer used, then the chemists had their turn, and they showed most conclusively that no mere contact could maintain a current unless heat disappeared at the junction, a fact obvious enough to us to-day, on the principle so laboriously and finally established by Joule. By means of the galvanometer the contact theory was so belaboured by Faraday, that it ultimately seemed to give up the

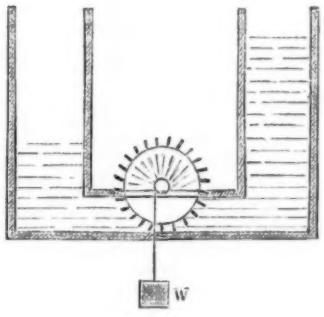

FIG. 1.

Prof. Lodge's hydrostatic analogue of the real difference of potential produced by a Seebeck force; and of the Peltier effect. W is a weight driving a water-tight wheel until stopped by the difference of level set up.

ghost, and the chemical doctrine triumphed; so much so, that Volta's original fact, in spite of the evidence which had been accumulated, was again doubted, and one finds in the text books culled from this period statements that Volta must have rubbed the plates together, or that there was moisture in the air. Also hints are given that films existed on the plates, that coats of

varnish or lacquer might produce electricity, and so on. It was pointed out by De la Rive how minute a trace of chemical action could produce how much electricity, and how little electricity could affect an electroscope. But it is to be noticed that any chemical action caused by damp on the plates or moisture in the air would be of the nature of local action, and local action is not a satisfactory producer of manageable electricity.

Quite detached from any connection with the controversy, because at that time quite unintelligible to all but one or two here and there, two papers appeared in 1851 by the president of this Association, which were the triumph and apotheosis of the chemical theory of the source of the current in the voltaic cell. In one of these papers, that on *electrolysis*, it is irrefutably established on the basis of the conservation of energy, that making exception of such irreversible effects as are not readily brought into calculation, and allowing for certain possible reversible facts to be investigated thermo-electrically, the E.M.F. of a cell is not only dependent on the chemical action going on, but is calculable chemically in absolute measure from purely chemical data supplied provisionally by Dr. Andrews. It is proper to say, however, that this brilliant theory is avowedly based on the laborious and acute experimental work of Joule on the conservation of energy in the voltaic circuit. In the other of the two papers, that on thermo-electricity, it was shown that from the fact that the current absorbed or generated heat at the metallic junction, an E.M.F. was necessarily existent there; in other words, that the Peltier effect necessitated the previously discovered Seebeck one. The establishment of the conservation of energy by Joule for ever placed beyond doubt the fact that the energy of the electric current produced by a battery was due to, and was the equivalent of, the chemical actions going on there; but it was supposed, and is still supposed, though, as I venture to think, quite erroneously, to leave untouched the question as to the precise seat of the E.M.F. in a battery. However that may be, the success of the chemical theory of the electric current naturally causes it to be still more certainly assumed that the apparent contact force of Volta could also be accounted for by accidental chemical action, and that without some chemical action somewhere no Volta effect could be produced. This also, I believe, to be quite false.

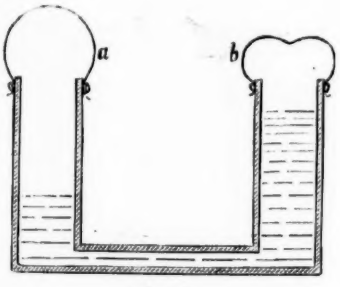

FIG. 2.

Prof. Lodge's hydrostatic analogue of the *apparent* difference of potential produced by contact, or of the Volta effect. *a* and *b* are air-tight elastic bags differently stretched.

The triumph of the chemical theorists with regard to the Volta effect was, however, short lived, for in 1860 to 1870 the invention of the quadrant electrometer put into the hands of electrostatic experimenters a far more refined and delicate instrument than could have been thought possible a few years before, and the illustrious inventor of that instrument himself for ever put the truth of Volta's phenomenon beyond doubt by the most simple and beautiful device of suspending a charged torsion arm over a zinc-copper junction. By comparing the deflection so produced with that caused by a Daniell cell an absolute measure of the so-called contact force was made, and it was shown that uniting the copper and zinc by a drop of water instead of by a metal, no deflection was produced. It was also shown that the deflection was greater with clean zinc and oxidised copper. But Sir William Thomson went further than this. He sounded a theoretical note, and in a sentence revived the whole controversy about the seat of power in the pile. The sentence is this:—"For nearly two years I have felt quite sure that the proper explanation of voltaic action in the common voltaic arrangement is something very near Volta's, which fell into discredit because Volta, or his followers, neglected the principle of the conservation of force. I now think it quite certain that two metals dipped into one electrolytic liquid will (when polarisation is done away with) be at the same potential." And then he goes on to one of those brilliant and extraordinary speculations characteristic of no one else, and applies this apparent contact force to determine an upper limit for the size of atoms, an application obviously of transcendent interest, and of more importance than all the previous outcome of contact discussions put together.

The whole subject now acquired a fresh interest, and a new series of experimental determinations of contact force began. Hankel's and Gerland's measurements belong to this period in point of date, though in method and motive they probably are the outcome of the earlier period. Hankel uses a modified Kohlrausch method, and Bohnenberger's electroscope. The especial merit is the determination of contact force without introducing blotting paper, glass, or fingers, as the earlier experimenters had done. Clifton employed Kohlrausch's method in 1877. He used a Thomson electrometer and a Clark's cell as standard. He has only published a preliminary paper, in which he overlooks minutiæ such as the change of the contact force by adventitious circumstances. When he touches on theory, he agrees with Thomson. Ayrton and Perry, in 1876, devised in Japan a very ingenious but somewhat cumbersome and unwieldy modification of Kohlrausch's method, and with the help of students carried out a most extensive series of determinations of metal-metal and metal-liquid and liquid-liquid contacts. On the appearance of Clifton's paper a year after on the same subject, they issued a strongly-worded

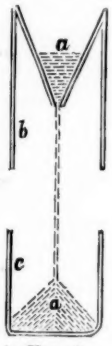

FIG. 3.

Sir William Thomson's Volta-electric electrophorus or gravitation voltaic cell, in which gravitation plays the part that chemical action does in the ordinary cell. *a*, copper filings; *b*, inductor-zinc; *c*, receiver.

claim in respect both of priority and completeness, a claim which seems to me well established, since their results are the most comprehensive yet obtained; and the energy needed to devise, construct, and use such an apparatus as the one they depict must have been immense. A convenient summary of their work is to be found in Everett's Units and in Gordon's Electricity, both second edition. The main result achieved by them was the experimental establishment of the summation law for any substances (this is not to be confused with Volta's summation of series law, which is only applicable to metals), viz., that the total E.M.F. of a closed circuit of any number of substances may be reckoned by adding up the Volta forces observed electrostatically for every pair of substances in contact. This law is, it seems to me, in the highest degree probable theoretically, but still it is important to have it experimentally established, especially as they point out that it is often called in question without good ground. The establishment of this law is perhaps their main work in this matter. Clifton arrives at the same conclusion, and gives a handy diagram of the contact forces at different junctions. My own opinion is that the intended and obvious significance of these diagrams is theoretically wrong; but they embody certain experimental results conveniently, and can be interpreted properly. I believe Prof. Clifton, as well as Profs. Ayrton and Perry, have made many more experiments besides those recorded in their communications to the Royal Society; but as they have not been published I can give no account of them.

Among the Thèses presented to the faculty of sciences in Paris in 1881, we find an important memoir by Pellat, which reviews the whole position very clearly, and records a series of determinations of Volta forces among metals which are evidently the most accurate and satisfactory yet made. He adopts the capital plan of neutralising the charge of a condenser by the Poggendorff method, and thus converts Kohlrausch's into a null method for which a

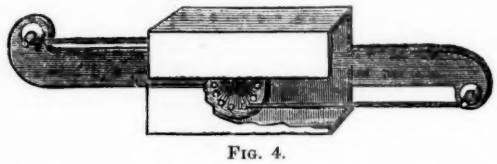

FIG. 4.

Sir William Thomson's voltaic replenisher or inductive electrical machine excite by contact force.

very sensitive electroscope is all that is needed. The plates of the two metals set face to face are connected, not directly, but by a greater or less length of a graduated wire conveying a current, and the position of the slider on the wire is adjusted by continually separating and testing until no charge at all is found. The step of potential on the wire is then precisely equal to the contact force between the plates which would have caused the charge in a similar uncompensated condenser. Compensation methods of a sort had been used before by Girland and by Thomson. Girland applied compensation to determine the E.M.F. of two liquids dipped into a liquid, and Thomson applied it to the divided ring experiment, thus making it very analogous to that of Pellat. Pellat also takes Sir W. Thomson's view that the effect is due to a true contact force between the metals, and that it represents a real difference of potential between them. At the same time, he is careful to point out that no rigorous proof can be given of this, and that all that is actually measured electrostatically

is the difference of potential between what he calls the electric coats or what may be more simply called the air films on the two touching surfaces.

Meanwhile, some experimenters, starting with a belief in the chemical origin of the Volta effect, had made experiments supposed to support this view. Mr. J. Brown, of Belfast, in 1878, repeated Thomson's divided-ring experiment, as well as Kohlrausch's condenser experiment, in other gases than air, and found a very decided difference, and even a reversal of sign when sulphuretted hydrogen was substituted for air. The metals he used were copper and iron, and he obtained a 1-centimetre deflection in a direction indicating iron + in air, while in SH^2 he obtained a 3-centimetre deflection indicating that iron was −. On readmitting air the deflection again reversed; and so on, until the copper coated itself with a blue film of sulphide, when the deflection became undecided, owing as he supposed to the cessation of chemical action. In 1881, he observed the volta effect with a copper-zinc junction and reckoned that at the first instant after cleaning the potential difference would be a ·9 Daniell, which he says agrees with J. Thomsen's determination of the difference of the heats of the combustion of zinc and copper and oxygen. He here gives a hint holding the heterodox notion which I do not find in any other of his writings and which I believe he has abandoned, even if he ever really held it. In 1879, Brown tried a copper-nickel divided ring, substituting H.C.L. for air, and then he also succeeded in obtaining a reversal of sign. He also arranged a divided ring of wet blotting paper and showed that there was a difference of potential when the two halves were touched with a zinc-copper couple (which is not remarkable), but he then goes on to draw a moral, and to say that the slit of the divided ring corresponds to the air film and the wet paper to the moisture film in an ordinary volta condenser experiment. The film of moisture on the zinc plate is thus shown to have a plus charge and that on the copper a negative. If it be objected that the better the plates fit the better the manifestation of contact E., it is to be replied that it is not to be supposed that there is *no* air between them anyhow, says Brown. Probably, he says, you produce the difference of potential only so far as it forms a film on the surface. When a metal and a liquid are experimented on it is probably a two fluid cell, the other fluid being that condensed on the surface of the metal. Brown thus goes hot and strong for the activity of the films of condensed air which are certainly on the surface of solids and which may play an important part in the matter. But he supposes that these films act by corroding or attacking the plates, and that such a film is necessarily existent between surfaces nominally in contact if any volta effect is to be produced, so that if the metals really and truly touched all over, they would show no charge when separated. Moreover he lays it down that the potential difference is only observed while chemical action is going on, but that so soon as it ceases from any cause at once the volta effect ceases. In all this I entirely differ from him: but his experiments are very interesting, and much to the point.

They cannot however be regarded as settling the question, the very important and fundamental question, as to whether the volta effect depends on the atmospheric or medium surrounding the plates, or whether it is an absolute effect dependent on contact. Experiments on this point are absolutely discordant, and it seems to be one of these points which it is very difficult to settle by direct experiment. For if by using a chemically active gas instead of air you get a positive result or change in the volta effect, the answer from the other side is: "Yes, of course; because your plates are corroded and coated with sulphide or chloride or something whose contact force comes in and modifies everything." If on the other hand you get a negative result when you substitute some inert gas like hydrogen for air, then it is objected that you have not removed the air-film which the plates had contracted from long standing in the air, and if you answer indignantly that you did, and that your hydrogen was perfectly pure, it is replied with a sneer:—"Oh, yes. It is not so easy to get pure hydrogen as you seem to think." Moreover, suppose a positive effect in changing the gas was established, what then? Nothing is settled, except the metal air contact force is somewhat different from the metal-gas contact force. There seems to be really no way of knocking contact force on the head experimentally, and this, probably, because it is a reality. *There really is contact force at every junction of dissimilar substances, and the E.M.F. of a circuit, whether it be inductive or conductive, is always the sum of such contact forces.* I do not say that the contact force at any given locality has the value ordinarily assigned to it as the result of experiment. The earliest attempt to examine the question as to whether the Volta effect depended on the atmosphere was made by Pfaff in 1829, who used dry and damp air, oxygen, nitrogen, hydrogen, carburetted hydrogen and carbolic acid, and he found that there was no difference so long as no visible chemical action occurred. De la Rive, on the other hand, asserted that there was no Volta effect in the slightly rarefied air then known as vacuum. In recent times Pellat has investigated the subject, and has come to a conclusion in agreement with Pfaff, namely, that the difference is very small. The gases he used were dry and damp air, dry oxygen, dry nitrogen, dry and pure hydrogen, and dry carbolic acid at different pressures. Copper and zinc were the metals employed.

Von Zahn also tried platinum and zinc condenser in the highly rarefied air now known as vacuum, with some melted sodium in a drainage tube to absorb all the oxygen, the Volta effect was diminished, and only represented a potential difference of half a Daniell. I am not clear whether sodium can be trusted to ultimately absord every trace of oxygen, but I should judge it would take a very long time; and as to rarefaction—dividing the numbers of molecules in a vessel by a million or two, leaves them quite numerous enough to accomplish anything they want. The views of Ayrton and Perry on the subject of the effect of the atmosphere underwent modification between their first paper and

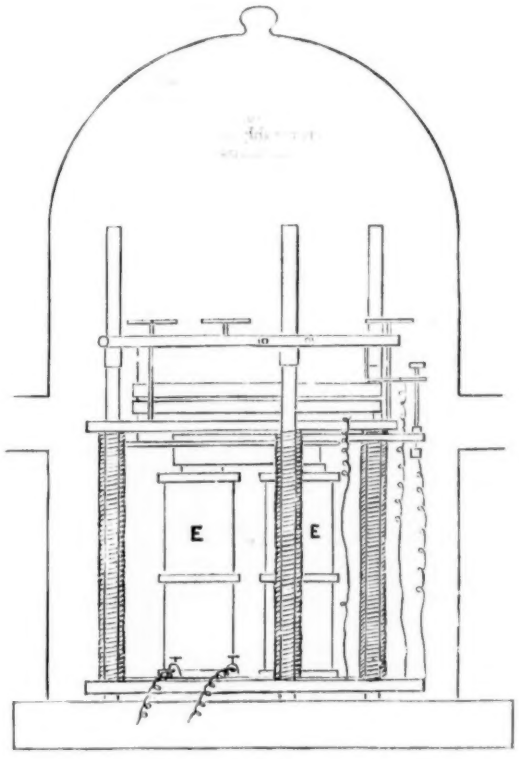

FIG. 5.

Pellat's apparatus for measuring the Volta effect in different gases at different pressures by means of a compensation method. The electro-magnet, E, is used to separate the plates the required small distance.

their third. In the first paper they say "they have good reason to believe that there is no great difference of potential between a metallic or liquid surface and the air in contact with it." Clerk-Maxwell, in a letter to the *Electrician* in 1879, poked fun at them for this, saying, "A statement like this coming from men whose scientific energy seems likely to displace the centre of electrical development, and to carry it quite out of Europe and America to a point much nearer Japan, is worthy of all attention, even without an explicit statement of their 'good reason;' but Mr. J. Brown has shown (*Phil. Mag.*, August, 1878) by the divided ring method of Sir W. Thomson, that whereas copper is negative with respect to iron in air, it is positive with respect to iron in hydrogen-sulphide. It would appear, therefore, that the reason why the results of the comparison of metal by the ordinary 'contact force' experiments harmonise so well with the comparison by dipping both metals in water or an oxidising electrolyte is not because the electromotive force between a metal and a gas or an electrolyte is small, but because the properties of air agree, to a certain extent, with those of oxidising electrolytes. For, if the active component of the electrolyte is sulphur, the results are quite different, and the same kind of difference occurs when hydrogen-sulphide is substituted for air."

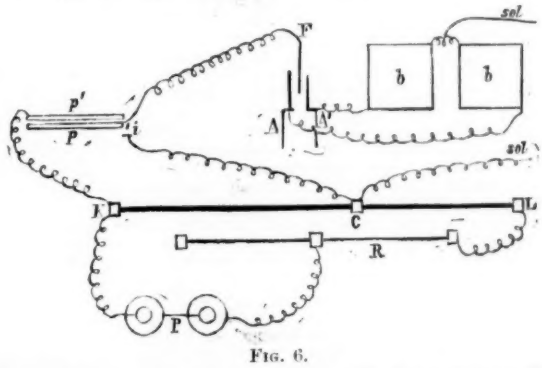

FIG. 6.

Diagram of connections in Pellat's compensation method of measuring contact force. K L, compensator; C, slide; R, rheostat; P, Daniell's cells, furnishing the current to the compensator; $p\,p'$, condenser plates, the lower fixed, the upper movable; i, interrupter; F, gold leaf; A, A', electroscope plates; b, b, batteries of 100 volts each for charging the plates, A, A'.

In their third paper, therefore, we find their views changed, and they clearly point out that their experiments, like all inductive methods, leave the air contacts quite undecided. They then go on to say:—"One way of determining the E.M.F. of contact in volts between a substance and air, and one which we hope shortly to employ, is to repeat all those exact experiments in different gases. (It is not quite true that this would give the result aimed at, because it would give differential effects, very important to observe, no doubt, but not the same as observing the actual contact force of air or gas.) We shall thus ascertain whether the contact difference of potentials of a substance and a gas differs much for different gases. Qualitative experiments in this direction have already been made with very interesting results by Brown of Belfast, but his experiments differ from ours in not being quantitative." Only, as their experiments do not yet exist, Mr. Brown's have still some value.

(To be continued.)

THE NATIONAL CONFERENCE OF ELECTRICIANS, PHILADELPHIA.

(Reported specially for the "Electrical Review.")

(Continued from page 351.)

HERE is another form of magnet (fig. 7); that machine would be defective. It has two magnets in the place of one, and it has two magnetic circuits in the place of one; and many of the lines of force probably make little private circuits of their own around in that way (arrows). Those lines of force are of course lost, and therefore it is more or less defective in that respect. There are machines which this figure represents exactly, but it is not meant for any particular machine; it is meant for a scientific drawing. I am only giving a general idea of the principle of these machines, and I do not refer to any particular machine.

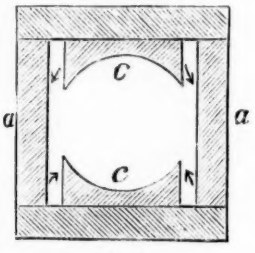

FIG. 7.

It is also important that this line of magnetic induction shall find easy passage around in order to produce the most intense field. Suppose this was the pole, *c*, then the opening at the sides must be made as wide as possible; everybody recognises that! The reason for that is in order that the lines of force may find easy passage across this opening, *c* to *c*.

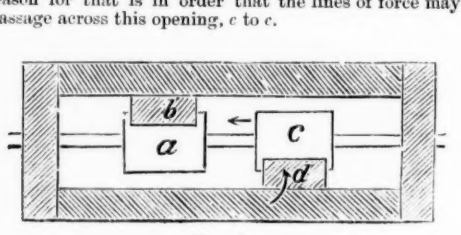

FIG. 8.

Suppose we had a machine made in the following manner (fig. 8). I do not want to say that it is anybody's machine; I may not have made the drawing right; but, suppose there was such a machine, and that somebody did make it, in which there was a magnet with a Gramme ring here, *a*, and a pole piece here, *b*, one ring here, *c*, and another pole piece here, *d*. How are the lines of force to pass? I do not know that it would be easy to see how; there is no easy passage. They evidently go around here (arrow) and strike into the Gramme ring, and I suppose pass across the opening here (arrow) and go to the other side the best way they can. You see there is no easy passage around for the lines of force in this case.

A MEMBER: May they not to some extent follow the shaft?

Prof. ROWLAND: It may be possible for them perhaps to go down and around, but it is evident that if the shaft is made large enough they come together around in that way, from *d* by shaft to *b*, but it is not so easy for them as to go across.

I have here a formula for the amount of work which one has to put upon a magnet to produce a certain effect. I will take the case which I have considered most efficient, where there is one magnetic circuit. Here you will have the lines of force going around this machine in this manner.* The reason they go around is from what I have sometimes called a magneto-motor force. It is not a very bad term to be used. It is an original idea of Faraday that these lines of force are conducted by a metal. We suppose these lines of force pass around this (arrows), and then they have to pass through the iron, and across the opening in this way (indicating), and they are caused to do that by what may be called the magneto-motor force of the helix. The magneto-motor force of that helix is proportional to the number of cores around the magnet, and proportional to the current, C, in the wire. I won't write down the exact expression for this quantity; I will only say the magneto-motor force is proportional to N, the number of turns around the magnet, and C, the current. The number of lines of force which pass around here we may call B. This is not the quantity which Maxwell considers, but it includes the whole number of lines of force which pass through the magnet. We may write B, proportional to N, the number of turns of the wire, and C, the current; and inversely proportional to the resistance of these lines of force in going around this circuit. The resistance of the lines of force is proportional to L. the length of the iron of the system, divided by S, the surface cross-section of the magnet, supposing it to be a uniform surface into π, the magnetic permeablity of the iron (or you may call it the conductivity of the iron for the lines of force). This quantity, π, varies with the current; it can readily be obtained; indeed, some years ago, I gave a formula for it. It can be expressed simply as dependent upon the magnetism of the iron and a constant depending upon the iron alone. Then to this we have something more to add.

Let l be the width of this opening (indicating), and A, the area across which the lines of force flow; then we have to add $\frac{l}{A}$; we have still to add to this a certain quantity which we can call p, which depends upon the resistance of these lines of force which escape in all directions. It represents loss due to the escapement of the lines of force. Thus we have the final value for the magneto-motor force

$$\frac{N\,C}{\frac{L}{S\,\pi}+\frac{l}{A}+p}$$

This gives us an equation which may be solved without respect to π.

It is evident that the curve for the magnetic permeability is of this nature. It rises to a maximum here, and then decreases. It will not rise as much as this diagram (fig. 9) indicates, but it will be of a more flat form, according to the value of l, and p. Therefore, increasing the magnetic force on your magnet, a certain point will be arrived at where it becomes very easy to magnetise a magnet, and after that it becomes harder and harder to magnetise the magnet. So that in practice you should get the form

FIG. 9.

of this curve, so that it should produce a very strong magnetic field; this can only be done by an exact calculation, or better by experiments on the machines, examining at each point the force of the current, and in that way getting an idea of how these lines of force go, and we can then see whether this area is large enough to take all the lines of force necessary to pass around. The mathematical investigation is a long one, and I cannot take it up here. I have here an expression for the work necessary to keep up a proper field in the magnet. Of course, as you coil the wire on these magnets, the coil becomes thicker and thicker, and in order to have a sufficient magnetic force across this opening with sufficient velocity you must have sufficient wire. As you increase the thickness, of course you have to use more wire for a certain core. Every core acts very nearly the same as every other in producing force; therefore, if you have the magnets very short indeed, you have to pile up your wire to a very great extent. The wire is made of copper, and as iron is cheaper than copper it might be better to lengthen out the core slightly. I don't know where the lengthening should end, but I should suppose you would lengthen out the core until the given length of wire on the magnet may make a moderately thin layer. Of course, as you lengthen out your magnet, the resistance to magnetisation becomes greater; but that is a very small quantity; I do not suppose it increases very much for a considerable lengthening of the magnet.

As I said before, the magnetic conductivity of iron is many times greater than that of air, and we can lengthen out the cores without producing much loss on account of that lengthening. Some persons have suggested that there may be a slight gain from the fact that iron after it has been magnetised a great number of times in the same direction, rather likes to be magnetised in that same direction afterwards. If the core is made of any material similar to steel, such as wrought iron, or anything of that sort, it might be possible to have some gain from the coercive power of the magnet. There would be a loss from that cause;

* See arrows in fig. 3, ELECTRICAL REVIEW for last week.

you have to act against the force of the magnet at first; but from the continual use of the machine, I think very likely the iron might get a set in the direction of the force which might possibly aid in the production of a suitable dynamo. If the core was of steel it is evident that you could send a strong current through at first and magnetise the steel, and then diminish the current slightly. We could thus still keep up a very large force at this point and with a moderately small current. I do not know how probable that would be, but it seems to me that one could produce a very strong field in that way. It may possibly be of practical value, and it might be tried. In the commencement of the operation of the machine we should have to send a powerful current to magnetise the steel, and then, without stopping the current, to diminish it; then the force of the steel would be in the same direction with the current and produce the field with less expenditure of energy than if it were simply iron.

As far as the difference between a shunt machine and a series machine is concerned, there is no difference. The magnetising force of this magnet is proportional to the number of turns multiplied by the current; that is, proportional to the cross-section of the coils multiplied by the current per unit of the section; so that the magnetising action can be the same with a machine which produces a strong current and a machine which produces a weak current. If you calculate the energy, you will find it is the same, because it depends upon the current into the cross-section. If the exterior dimensions of the coils are the same in both cases, the same energy is expended in each in order to produce the same force, therefore there is no difference between a shunt machine and a series machine; I think the energy will be the same for both.

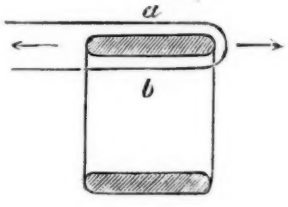

FIG. 10.

I do not wish to take up too much of your time, and I will go right on to the heating of the armature. Of course, the amount of energy expended in the heating of the armature will be dependent on its resistance; and the efficiency of the circuit will merely depend upon the relation between the resistance of the armature and the exterior resistance; that is very well known. There is one other point; there is a certain lot of dead wire, you may call it—I do not know the technical term, I think very likely that that is the technical term. In the first place I will only discuss the Gramme and Siemens armatures. In the Gramme machine you have the armature inside of the ring, and the ends do not act at all. In the Siemens armature, we have the coils brought over the ends of the armature. It is only a question of the work of the machines, and the relation between the two. In the Gramme machine it must be less than one-half of the wire that is acting. You have the section of the Gramme ring like that (fig. 10), and when that portion of the wire, *a*, is active, of course this portion, *b*, inside is dead. I suppose some of the lines of force go out here (arrows), so that we can see at least half the wire is dead wire.

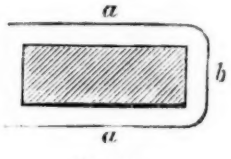

FIG. 11.

In the Siemens armature one cannot say immediately how much dead wire there will be, because it depends upon the length of the armature. In the Siemens armature you have the wire wound around in that way (fig. 11), and this portion, *a*, would be active and this portion, *b*, dead. Of course, if the armature is very thick, you would have more dead wire than when it is simply long. I cannot say which has the more dead wire, but I dare say the Gramme has more than the Siemens. Furthermore, either in the Gramme ring or the Siemens armature—I will draw this figure to represent either the Gramme or Siemens armature—you have the lines of force running across here (fig. 12), across here, dotted lines; that portion is active, and this portion, *a*, in between the poles is dead; and when the thing revolves you have the lines of force turning around, and I think that would add more dead wire to your machines. I believe an attempt has been made to throw out these coils; I believe in some form of machines they are thrown out; this is a practical point which everybody can understand, and if I should look over the Exhibition carefully I should find some machine in which this is taken account of. There is no necessity to go further. Of course, the efficiency of the circuit depends upon the ratio of the resistance of the armature to the resistance of the wires, and therefore, as far as this point is concerned, any machine can be just as efficient as you please by putting in greater and greater external resistance. But as the magnet remains the same you would find a point where the efficiency of the machine as a whole would not increase

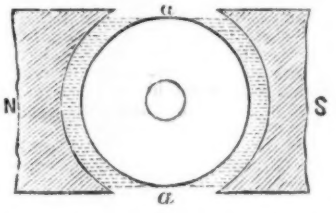

FIG. 12.

for an increase of external resistance, and the work would actually diminish. There are other things to be taken account of; there are some losses due to the self-induction of the coils which produce sparks in them. I have requested Prof. Fitzgerald to take up that point, and therefore I will leave it for him to consider.

Now I shall consider another point with regard to the dynamo which can be treated in this simple manner with no use of the calculus. I think it can be done by very simple reasoning if you only know the principles. I shall now attempt to construct two machines similar in all respects, but one of which is larger than the other.

We can suppose that we construct one of the machines and then see what the effect will be when that machine gradually grows and becomes very large.

The point we shall start from is that the magnetic field is constant in the two machines. Owing to the fact that there is a limit to the magnetisation of a magnet, we cannot have a field which is produced by iron with more than certain strength; therefore, I suppose that you get up to a reasonable strength with your iron. It cannot be up to the maximum strength of course, but it is somewhat near it. I made some experiments many years ago upon an ordinary magnet, and the results were published, I think, in Siemens's journal; it is beautifully applied to the dynamo machines, and I obtained everything with it that I have referred to here. With that apparatus, if I remember rightly, I got about one third of the force in the field of a magnet that iron could possibly give; of course you could get greater. It is theoretically possible to get a force equal to the magnetisability of the iron, or the maximum magnetism of the iron; but, practically, I suppose the case is very similar to that of the ordinary dynamo machine.

Therefore we can say that the field of force in the two machines, one of which is larger than the other shall be constant, and I will therefore write down F = constant. It is not only constant in one part of the machine but in all parts; the magnetising force at every point of one machine is equal to that in a similar point in the other machine. Therefore if you drew the machines on the board it would not make any matter about the scale of dimensions of the machine; you could mark down the force at a certain point as being a certain amount, and consider the scale whatever you please.

Starting from that point, we will consider what must be the current in the wire in the two machines. The machines have the same number of turns around the magnet, and everything is the same, except that the dimensions of one machine are greater than the dimensions of the other. I will give you a formula for the current in the wire: suppose you have a tangent galvanometer, consider the current passing around its coil. If you make the circular wire of the galvanometer grow in order to produce the same effect at the centre, you must add current in direct proportion to the radius of the coil. If you make that coil twice as large you must have the current twice as large in order to produce the same force at the centre, and not only at the centre but at every point. If the material is constant there is no difference in the iron, we have the current in direct proportion to the linear dimensions of the figures, so that the current in the wire varies as the linear dimensions of the machine. Make one machine twice as large as the other and the current per unit of area in the magnet must be twice as great to produce the proper motive force; of course the wire has increased in size. If the machine has increased to twice its original size, the cross section of the wire has increased four times; in other words, from that cause the current per unit of area will vary inversely as the square of l, the linear dimension; and since we have found the current to vary directly as l, in order to retain the same force in the field by a combination of the two results, it varies inversely as l. Therefore as far as the magnets of a machine are concerned, if the machine grows larger in this way its heating effect, which depends upon the current per unit of cross section, will be less, since the surface will have been increased in proportion to the square of l; there will therefore be less danger of heating in a large magnet than in a small magnet; this is only with respect to the magnet. In some cases it is practically found harder to run a large machine than a smaller one, but we shall find how that comes.

The resistance of any part of the machine or the work of the armature varies, of course, directly as the length of the wire, and inversely as the cross section. The cross section varies as l squared, so that the whole work varies inversely as l, or the resistance varies inversely as l. Therefore the larger you make the machine the less the resistance will be; one machine being twice as large as the other, the resistance will be half as great.

I will now consider the electromotive force. This applies not only to the work of the magnet, but also to the work of the armature: we have here the current and the resistance. The electromotive force is proportional to the product of the current and the resistance, hence we may write $E = R C$. Therefore the electromotive force of this machine will be constant. We shall presently see how this is modified, so as to get the electromotive force greater for the larger machine. The work done is therefore equal to $C^2 R$ in any part of the machine, or in the whole machine, just as you please. But that quantity varies directly as l, the linear dimension. Therefore the one machine which is twice as large as the other requires twice as much power to run it, and you get twice as much electrical energy out of it. But it is to be remembered that the weight of the machine varies as l^3, and you have only got l times the work out of it as constructed in this way.

Let us see what the reason of this is. The field of the magnet is the same. There are just as many lines of force in the armature in the two machines, and when we calculate up we shall see that the angular velocity of the armature, or the number of turns per second or minute, must vary inversely as l^2. In other words, in one machine twice as great as another, the velocity of the armature must be only one-fourth as great, in order to produce the same current in the wires. This takes account, I think, of every irregularity in the machine; the two machines are exactly the same in every respect. I have not added the loss for the self-induction of the coil. I have an idea that this also should be taken into account, but Mr. Fitzgerald will consider that point.

So far as the results go, we have constructed two machines which differ only in size. The efficiency of these two machines is a constant quantity. That will be rather startling to some who come to me constantly and say "a larger machine is more efficient than a smaller one." As far as this thing goes, we have constructed a machine which is larger than another, and in which the efficiency is the same.

Let us see the cause of the efficiency remaining constant. On what does the efficiency depend? We have got to keep our magnetic field the same in both cases; and therefore the work done in sustaining the magnet will be this: ($C^2 R$). But here we have the angular velocity inversely as the square of the linear dimension. The question comes up again whether we cannot increase the velocity of the armature above that point. Is it practically necessary that we should run one machine at one-fourth of the velocity if it is twice as large? It is a practical question as to what we can get; I should think it certainly was not in this proportion, I should think it would be more nearly inversely as the size, and not inversely as the square of the size. Can we not then run the machine with greater angular velocity? We certainly can do so by increasing the external resistance, so that the same current flows when you run it fast, as in this case. Then the driving force will be the same, and the whole machine will be increased in efficiency. We can do that to a certain extent; I do not know where it will end practically; but starting with a small machine, without increasing the electromotive force which is constant in these machines, but by arranging the wire of the armature so as to increase the external resistance, we can increase this speed, and yet have the current per unit of section through the armature the same as in this case. If we do that, we shall be able to increase the external resistance of the machine in comparison with the resistance of the armature, and when we do that we increase the efficiency of the machine.

I think it is from this cause that we find large machines more efficient than smaller ones. But it is also evident that there is a limit which can only be obtained, I suppose, from practically making the machines, and seeing how fast they may be run without flying to pieces. If we can keep them going at a greater rate of speed than I have pointed out as they are increased in size, I suppose the efficiency will be increased.

As far as this theory goes, the increase comes not from the size of the machine but from the fact that you can get a greater electromotive force with the same angular velocity, and so can increase the external resistance in proportion, so that you find in very large machines you can make the wire with one turn around the armature, not several turns—just have bars on the machines. We thus decrease the resistance of the machine, and at the same time we run it above this relation which I have pointed out, and so obtain the proper electromotive force. The proper electromotive force is more easily obtained from the large than the small machine, because it is not practically necessary to decrease the velocity. I will ask Prof. Fitzgerald to continue the discussion on the loss due to self induction, and then the discussion will be open.

Prof. FRANCIS J. FITZGERALD: Mr. President and gentlemen, I feel that I have to apologise to you for having been led into the question of the effect of self-induction; and I have partly to apologise for not having had sufficient energy to investigate this thing very carefully, and that my information upon the subject is not brought as distinctly to mind as it might have been. The warmth of the weather and the incurable hospitality of the American people have not left me time to investigate the matter.

The point which I was led to call attention to frequently some years ago, and which has been investigated and experimented upon by several, is this:—Taking a coil in which the current is being started from there to there (a to b, Fig. 13); the current is going in this direction (small arrow), and the ring is turned in that direction (large arrow); when the coil was at that side, d, the current was running down through it in that direction (arrow); as soon as the current passes across the brush at b it is reversed, the current passing off. Consequently the current which was at one time running in one direction, is reversed so as to cause the current to be running in the opposite direction. That in itself necessitates no loss of energy. The work that is to be done in stopping the current and turning it in an opposite direction does not in itself involve any loss of energy, if energy in stopping the current could be utilised in starting it again. If you could use the energy which is necessary to stop the current to start a fresh current in the opposite direction, there would not be necessarily any loss of energy in your arrangement; but what I want to call attention to is this; that in general a coil is short-circuited when it is passing from one of these positions to the other across the brushes, and consequently the energy in stopping is used in sending sudden and short currents through itself. There is in general a circuit through the coil, which is in short a short circuit in itself, and the energy of the coil which goes out in stopping is not used in starting the current in the opposite direction. Therefore you have lost the energy of the coil due to its own induction through a short circuit.

The loss of energy due to this cause for this coil will be proportional to the induction and the square of the current passing through it. If M is the induction of each coil, and C the current passing through it, $M C_2$ is the loss of energy due to the self-

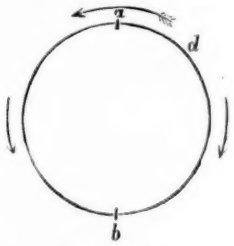

FIG. 13.

induction of the coil being wasted on the local current. This will be on each coil; hence, if N were the number of coils that were passed per second, $M N C_2$ would be the loss per second owing to this fact. This can be put into another form by substituting for $M N$ the terms of the self-induction of the unit of length of the ring. If V is the velocity of the edge of the ring, and L is the induction per unit of length on the ring, then necessarily $V L = M N$; and $V L C_2$ will represent the loss of power owing to the self-induction of the coils. For a given ring it varies directly as the linear velocity of the ring. It was a very difficult thing to make experiment upon this effect as to whether there was any loss of power due to the self-induction of the ring. The term $V L$ is in the nature of a small resistance, which we may call R, so that the loss may be written $R C_2$. This is a resistance of the machine due to its velocity, and is proportional to the linear velocity and the self-induction per unit of length. The resistance of the ring is easy to obtain by rotating the ring under the action of the earth's magnetic force. One great difficulty was to get an arrangement in which there should be no reaction between the magnetic field and the ring itself. Field magnets were therefore used instead of the magnetic force of the earth, and consequently there could be no reaction from induced magnetism in the earth, owing to the magnetisation of the ring. It was therefore assumed that the initial magnetic field was constant. That is the difficulty—to determine the reaction between the magnetism of the ring, and the induction which would be occasioned on the field magnets. A number of experiments were tried, and it was found that as far as the experiments went there was an increase of resistance owing to an increase of velocities, and that it was approximately proportional to the increase of velocity, and that it was approximately equal to what it was calculated it should be. It was found that the increase of resistance was a little larger than this amount; but it is almost impossible when turning a Gramme ring rapidly to prevent the jumping of the brush upon the commutator. The result of the experiments, however, led to the conclusion that the increase of resistance was to be calculated upon, and that there was a reason for not running dynamos any faster than a certain amount; that there was a certain velocity which it was well to not drive them at, because this internal resistance varied as the linear velocity of the ring. You can get over this resistance due to self-induction by constructing what are called unipolar dynamos.

First of all I may say something of the effect which Prof. Rowland called your attention to—the effect of size upon this apparatus. In the first place the angular velocity is inversely as the square of the linear dimensions. Therefore the linear velocity will vary inversely as the linear dimensions. Consequently the effect due to this linear velocity would be less in the larger machines, not more than half that of a machine of half the size.

The effect of the self-induction per unit of length of the ring will be independent of the size of the machine. For the coefficent of self-induction is in general proportional to the linear dimensions of the system. The coefficient of self-induction is in general of the dimensions of a line, and, therefore, the self-induction of a unit per length will be independent of the dimensions of the system. Consequently you will get this: the increase of resistance is inversely proportional to the linear dimensions. Inasmuch as the increase of resistance will be inversely proportional to the linear dimensions, and inasmuch as the current varies as the linear dimensions, you have that the loss of power will be directly proportional to the linear dimensions.

The whole power is directly proportional to the linear dimensions, so that the proportion of the power lost to the whole power will be constant and independent of the size of the machine.

It is possible by constructing what are called unipolar dynamos to get over this loss owing to the self-induction. For instance, take the simplest case of Faraday's experiment with a magnet rotating. In that case there is evidently no sudden change in the current. The current is gradually diminished. There is no sudden alteration in the current: it is a uniform action, and, consequently, there will be no loss in this case, so far as I can see, owing to the increased velocity at which it goes. You will have here the self-induction of the current diminishing, and helping to increase the current at some other point. Hence there will be no loss due to the stopping and starting. Some people find difficulty in understanding how there can be no loss in an opposing force. It is the case of a crank running upon a wheel; there is no loss owing to the reciprocation of the crank, the mechanical force that is required to start it at one end being given out at the other end. But in this case it is like a bad crank, which joggles upon its bearings; and in this case there is a loss by the reciprocation of the action.

In this case we have the loss due to short breaks, and in that case there would be a loss, owing to the increased pressure of the crank on the bearings. In every check of the crank there will be a loss, and hence in this case there will be loss, owing to the fact that you have to change the current from one direction to the other. But in this case of the unipolar machine it is like a crank axle in which the motion goes on uniformly without any unnecessary joggle round and round. Therefore there is no loss due to self-induction.

It is possible, also, to arrange Gramme armatures in such a way that there would be no loss owing to this cause, by arranging them so that there shall be a number of different brushes, and the current divided between these different brushes. The easiest way in which I can explain this is by taking the case of two Siemens armatures, the current being divided between them, part to one and part to another. Now, it is evident that it is possible to arrange the brushes in a certain position so that the brushes themselves shall make a contact in this armature at the time when the electromotive force is exactly the same as the electromotive force that is required to be sustained between those two wires, whereby the potential at the ends of the armature is the same as at the ends of the two brushes, the potential of the brushes being kept up while this contact is being made at the armature, so that you can make the contact with the brushes when the potential of the brushes is the same as the potential of the armature, and therefore there will be no tendency for the current to start or stop at that time through the armature, and therefore it must start gradually. On the other hand it is evidently possible to arrange the electromotive force so that at the instant of turning it shall be able to stop the current in this direction, but not to drive the current in the opposite direction; thus driving the current in this direction during a part of the revolution and in this direction during another part. During the intervening time, it is evident that there will be some instant in which there is no current running in this armature. If that is the moment which is chosen for breaking the current there will be no spark, owing to the self-induction at that time. So that by making the contact between the brushes and the corresponding commutator at the time when the potential of the brushes is the same as the end of the armature, and when there is no current running in that coil, you will necessarily have a machine in which there is no loss in this way owing to the sudden breaking and stopping of the current.

I would just like to say something in connection with the question that Prof. Rowland mentioned upon another point, and that is, that in a large dynamo you have got an obvious advantage; that it is possible to make the clearance very much less in proportion than in the small dynamo.

You can make the angular distance between the armature and the poles very much smaller in proportion in the large dynamo than in the small one, owing to the possibility of making the clearance much less. Another advantage in the large dynamo, on account of the electromotive force being nearly the same in the two dynamos, you may make the proportion between the area involved in the insulation and the area of the conductor smaller in the large dynamo than in the smaller one. It would not be necessary to make the area of this armature proportional to the linear dimension, consequently you can have a much larger conductor in proportion in the large than in the small dynamo; so that that is an additional advantage you can have in the large dynamo.

With reference to the centrifugal force. While I was waiting, I worked out a little point that I would like to draw attention to, and it was with reference to the Gramme ring. I have come to the conclusion that the tension of the material and the wires, per unit of area, will vary directly as the square of the linear velocity; and that therefore the velocity being inversely proportional to the linear dimensions, the tension per unit of area will vary inversely as the square of the linear dimensions; and that therefore you may drive the larger Gramme ring considerably faster than you could the smaller without any danger of its flying to pieces. I think the tension of the ring is exactly proportional to the square of the linear velocity. But I am not sure. I am sorry that this is all I can give you upon the subject.

(To be continued.)

NOTES.

Electric Lighting.—We understand that the Stanners Close Steel Company has decided to extend its electric light plant by the addition of some 10 Brush arc lamps, six of which are now being placed. As this firm has been employing the light for some time, the present extension speaks well for its success. The work is being carried out by the Hammond Electric Light Company, Limited.

Mr. Joseph Fearfield, of Stapleford, has, with the practical assistance of his son, Mr. J. P. Fearfield, introduced a most successful installation of electric lighting into his factory. The machines employed are three Gramme dynamos. The largest, capable of supplying 100 20-candle lamps, is used for nearly all the lights in the whole of the large factory, including clocks, passages, press rooms, &c. Another machine, capable of lighting 30 20-candle lamps, feeds the lights in the smaller factory at the rear of the main building. The largest machine is working at 50 volts, a current of 110 ampères being used when 93 lights are on. The smaller machines are working at 100 volts, and are only producing from 16 to 18 ampères of current. The whole of the dynamos are compound shunt-wound. Several lamps are in use, including Swan's, Edison's, Oppermann's, Lane-Fox's, British Electric Light Company's, Swinburne's, and Woodhouse and Rawson's. Mr. Fearfield began practically to use the lights on the 10th of August last, and, up to the present, only two lamps have really given out in working, and three globes have been broken by pure accident. In a room 75 feet by 45 feet, and 14 feet high, 24 lamps give a better light than 36 No. 5 gas burners used to do. The motive for the change is principally to provide a safeguard against fire-risk, which is now minimised, and also to free the atmosphere in the workrooms from the deleterious fumes arising from gas-lights. From the various data that could be obtained, he did not expect the change to be an economical one, but he now finds that, after deducting the slight extra cost of slack, and a little extra attention on the part of the engine-driver, the expense of lighting by electricity will not be quite one-third of the cost of lighting by gas; indeed, so satisfied is he with the new mode of illumination that he is having two larger machines fixed, and a new set of engines built for the purpose of lighting up the remainder of the lace machines, his own dwelling house, the boiler-houses, &c. Mr. Fearfield, jun., has carried out the entire work of fixing, &c., even to the finishing of the machines, and, being a member of the Institute of Mechanical Engineers, has had an application from the council to kindly throw open the works for the inspection of the members during their approaching visit to Nottingham; but this was thought somewhat impolitic on account of the lace machinery, and the honoured visit has been respectfully declined.

The works for lighting Temesvar, Austria, by electricity, are now completed, we learn from the Berlin correspondent of the *Times*, and on the 26th ult. all the street lamps were burning with half, and on the 27th with full power. The result is said to have been entirely satisfactory. On Saturday last the gas was to be done away with, and the illumination given exclusively by electricity. The official tests will begin on the 15th of November and continue till the 1st of December, on which day, if the tests are satisfactory,

a contract will be signed with the company concerned (the English International Electric Company).

On examination of the Capitol at Washington, where the electric light has been used, states the New York *Electrical World*, it has been found that the building presents a most untidy appearance by reason of the billions of insects which have been drawn thither by the brilliancy of the lights, and whose skeletons are either hanging on the walls, held fast by a death grip, or are piled up in heaps all over the recesses of the roof.

Every effort is being made by the contractors to complete the plant and machinery necessary for generating the electric light at the Royal Courts of Justice by Monday, when the Lord Mayor and Sheriffs will go in procession up the central hall in order that his lordship may be received and sworn in before Her Majesty's judges. Latest accounts, however, point to the improbability of their succeeding, and in all likelihood the imposing ceremony will proceed in semi-darkness. Mr. Justice Hawkins expressed great dissatisfaction with the lighting arrangements on Thursday, ordering the lamp alloted to him to be removed as worse than nothing. Next summer, he said, when they would not want it they would have a little light.

The Swan Company for Isolated Lighting of New York, about a month ago, started 500 incandescent lamps among the paper mills at Bellows Falls, Ct., with a thoroughly arranged plant. Contracts with other mills have already been made, which will carry the number over 750 lamps.

Hachette et Cie, the large firm of publishers and booksellers in Paris, with branch in London, have had their folding and binding departments in the Rue Stanislas lighted by incandescent lamps for two years past. So satisfied are they with the results, that they have now arranged to extend the electric light to the whole of their establishment, and have ordered 350 Edison lamps.

The following circular has been forwarded by the Secretary of the Universal Exhibition of Antwerp to the principal business houses engaged in electric lighting :—"The Executive Committee of the Exposition Universelle d'Anvers has decided that the rooms and gardens of the Exhibition shall be lighted by electric light. We have the honour to invite you to lend your assistance for this lighting and to quote the price which you will charge for installing electric lamps (besides those which you will be disposed to place gratuitously as an exhibit). The committee will be happy to see the greatest possible number of manufacturers participate in this lighting. In order to act upon the tenders and to arrange the distribution of the lighting among the various exhibitors, the committee will take the opinion of a sub-commission consisting exclusively of persons having no connection with any electric lighting company, and who alone will know the proposals made to the committee. The members of this sub-commission are Messrs. Devy, Dumont, Evrard, Gérard, L. Gody and Wijbauw, and it is under the presidency of M. E. Rousseau. The price should be given per carcel-hour for each intensity of lamp, from arc lamps of the greatest power (two of which are to be placed in the lanterns at the entrance) to incandescence lamps of every pattern. The measurement of the intensity of the lights will be taken naked, at the most favourable angle, with the Bunsen photometer and according to a mean furnished by three observations. The price should be given on the supposition of free motive power, and the power required for each type of lamp should be indicated. Gas for gas engines serving for lighting will be reckoned at 16 centimes the cubic metre. The lighting will last each evening until 11 o'clock, three times per week, from the 1st of June to the 31st of October. All the conductors will be aerial and insulated. In order to take account of the variable expenses for the establishment and for the mean value of the conductors after taking down, *one franc per kilogramme of copper* employed will be paid. The prices will include all the expenses of installation (including belts and pulleys); the cost of carriage according to the tariffs of the various countries; the maintenance of the machines; the fixing up and taking down of conductors; the fixing, maintenance and superintendence of the lamps. The supplying and erecting of the posts and supports for the lamps and cables will be at the expense of the administration of the Exhibition. A scale of special charges will regulate questions of detail, and you will be informed in sufficient time. Tenders must be sent in *before the 15th of November*.

Messrs. Andrew Usher & Company, distillers, Edinburgh, have adopted electricity as the illuminant of their extensive premises. While several advantages over gaslight are claimed for the electric light, that upon which most stress is laid, in the present instance, is its safety against the origin of fire. The installation has been carried out by the Anglo-American Brush Electric Light Corporation, Limited. A calculation has been made that the introduction of the electric light will effect a saving of 33 per cent.

The streets of Wycombe were brilliantly illuminated by the electric light last Tuesday, when the Prince and Princess of Wales passed through the town on their way to Lord Carington's residence, Wycombe Abbey.

Mr. Altman, Chairman of the Streets Committee of the Commissioners of Sewers, recently stated that an application had been received by the committee for electric lighting, which, with modifications, would probably be accepted; he saw no reason why the greater part of London should not be illuminated by the electric light.

Nine Brush lights, each of 6,000-candle power, are used at the Hell Gate Lighthouse, to illuminate the entrance to New York harbour, and vessels 40 miles out on the Sound have distinguished the steady glow. There is no difficulty in discerning the treacherous rocks in the once dangerous strait, and vessels can pass as readily at night as when the sun is shining.

Mr. F. C. Phillips, of 2, Victoria Mansions, Westminster, has during the past week been lighting the chrysanthemum show of Messrs. Cutbush and Son, at Highgate, by means of four of his new 10-ampère arc lamps.

Telephony by Underground Conductors. — Mr. T. D. Lockwood writes to the *Scientific American*, confuting statements made in that journal in relation to a paper read by him at the recent Electrical Conference at Philadelphia. The statements were that "Prof." Preece believed that wires may be efficiently and economically buried; that at a recent meeting of the telephone managers a paper was read by an employé of the American Bell Telephone Company, whose duty it is to keep the lines in running order, with the object of showing that telephone lines could not be efficiently operated underground; that at the conclusion of the reading "Prof." Preece took the writer severely to task for the incorrectness of his conclusions, remarking that "if that was the result of his investigations, he must sadly have neglected his business"; and that results with underground telephone wires were more than encouraging. "In the first place," says Mr. Lockwood, "Mr. Preece lays no claim to a professorship—he is chief electrician of the British telegraphs, and a Fellow of the Royal Society. Second. The paper was not read at any meeting of the telephone managers, but at the afternoon session of the fourth day of the National Conference of Electricians. Third. The duty of the employé of the American Bell Telephone Company who read the paper (myself) is not to keep the lines in order. Fourth. Not being actively engaged in the business of telephonic communication, the A. B. T. Co. has no lines. Fifth. The object of the paper was not 'to show that telephone lines at least could not be efficiently operated underground.' The subject then under consideration by the conference was: 'Induction in telephone lines, long line telephony, and underground wires,' and the paper, related to the subject as a whole, was prepared by request of

the U. S. Electrical Commission, and only incidentally touched on underground telephony. Sixth. Prof. (?) Preece did not take the writer severely to task for the incorrectness of his conclusions, although he freely criticised his premises. Seventh. Although Mr. Preece did make the remark cited, it was by no means with reference to underground wires, but merely referred to the omission from the paper of several methods for preventing induction which had gone into use in England. Eighth. The inference that Mr. Preece held the opinion that telephones could be worked for considerable distances underground is not warranted by the facts. The paper stated that telephone wires could not be successfully and commercially operated underground for a greater distance than 12 miles, and Mr. Preece fully concurred in that statement both at the Montreal meeting and at the Philadelphia conference; while the remark that 'even telegraph wires are constructed underground at four times the expense of overhead wires, while they are but one-fourth as efficient,' was made by himself not over a year since in a lecture before the Society of Arts in England. Ninth. It is not true that the results so far obtained with underground telephone wires have so far been encouraging. On the contrary, they have been discouraging. The articulation invariably becomes sluggish when the underground conductor exceeds two miles in length, and this effect is greatly accentuated when an overhead line of several miles in length is connected with the underground line. Increasing the sectional area of the conductor aids materially in overcoming the sluggishness."

New Telephone Company in Canada.—The Dominion Telephone Company has been organised at Montreal to manufacture and use the James Wright patents. The rentals to be charged are $55 the first year, and $25 subsequently; $30 of the first year's charge purchasing the instruments, and the $25 being for maintenance. A new feature will be the supply of private switches for 5, 10, and 20 wires. There are at present in operation over 100 sets of instruments in the townships, and over 60 miles of line have been erected, and 100 miles are in course of construction. The company expects to commence operations in Montreal in the spring. The invention was made in March by Mr. Wright, and since then the instruments have been in use, it is stated, without interference from the Bell company.

Telephone Extension in the North.—The Ecclesfield and Bradfield Highway Board, on Monday, gave permission to Messrs. Tasker and Sons, Sheffield, to erect telephone posts and wires from Wardsend Steel Works to Messrs. Moss and Gamble's works, Wadsley Bridge, and from the Asylum to Deepcar, on payment of 2s. 6d. per mile per annum.

Death of Mr. Fawcett, M.P.—Very great surprise and truly sincere regret, we are sure, will be felt by our readers when they learn the intelligence of the sudden death, on Thursday last, of the Right Honourable Henry Fawcett, M.P., her Majesty's Postmaster-General. The *Morning Post* in commenting thereon says: "The position which that officer holds in the Administration is not one which brings him into collision with the opposite party; but in his case much admiration was excited by his beneficial administration of his important office. He has passed away at an early age (51 years) for a statesman of our time, but not without having left his mark on the department over which he had been chosen to preside."

Australian Telegraphy.—Western Australia is engaged in constructing a line of telegraph along about 700 miles of its coast line, from Northampton to Roebourne, the objects being to establish speedy means of communication with the settlements near Roebourne; and to induce an English company to run a cable to North-West Cape from Java. The first and most difficult section, from Northampton to Hamlyn Pool, a distance of 140 miles, has just been completed: the poles are of iron and are in two sections.

Telegrams to Canton.—The Great Northern Telegraph Company announces that the rate to Canton has been reduced to 8s. 9d. per word from the 1st instant. A telegraph station has been opened at Swatow, for which place messages can now be accepted for transmission by this company's lines at the rate of 10s. per word.

The Telegraphs of British India.—Mr. H. G. James, Postmaster-General for British India, is at Berlin, studying the postal and telegraph institutions of the German Empire.

American Telegraphs.—Western Union stock, says the *Financial News*, when Mr. William H. Vanderbilt went out of the control and turned it over to the tender mercies of Mr. J. Gould, was selling at about $80 per share. It has since been doubled, and now sells at about $60 per share, or at the rate of $120 for old stock. Since Mr. Gould obtained control he has sold out pretty much everything of value to pay unearned dividends, and the treasury is as bare as a billiard ball.

Incandescence Electric Lamps.—We would call attention to the letter of Mr. Trotter on this subject in our correspondence columns. Perhaps others of our readers may have some information to give bearing thereon, the matter being one of much importance to all connected with the practical operations of electric lighting.

Use of Submarine Cables in Time of War.—The first issue of the *Admiralty and Horse Guards Gazette* contains an article upon this subject, in which it is urged that no squadron should be without a fleet telegraph-ship in time of war, and the various advantages, such as the ability to tap cables and transmit information in mid-ocean, to intercept the enemies messages, &c., are pointed out.

The Invention of Electric Telegraphy.—The Premier of Victoria has written to the Agent-General regarding the claims of Mr. E. Davey, surgeon, of Malmsbury, to be one of the earliest inventors of the method of using dynamic electricity for telegraphic purposes, stating that Mr. Davey is genuinely entitled to the gratitude and consideration of the whole civilised world, and mentioning that £100 has been placed on the Victorian Estimates this year. As an initiatory step, he requested Mr. Murray Smith to support the claim to be made on the Imperial Government by the Royal Society of Victoria through the Royal Society of London, on behalf of Mr. Davey.

Telegraph Clerks and Sunday Labour.—At a meeting of telegraph clerks at Newcastle last Saturday, a resolution was unanimously passed regretting the Postmaster-General's refusal to grant payment for all Sunday work in the provinces, while such work performed in London is paid for as overtime; and stating that so long as this invidious distinction exists deep dissatisfaction will continue to pervade the provincial staff. It was stated that in the service of the companies, and for some time subsequent to the transfer of the telegraphs to the Government, Sunday work was paid for as overtime.

Electrical Tramways in Blackpool.—The Blackpool Town Council has decided to enter into an agreement with Mr. Holroyd Smith to work the electric tramways in the borough for seven years, paying the corporation 6½ per cent. on the money it invests in laying down the lines. The tramways are to be in working order by June 1st next year.

Overhead Wires.—The Clerkenwell Vestry has appointed five delegates to join the conference at the Charing Cross Hotel, on the 17th inst., to consider the desirability of memorialising the Government to confer upon local authorities control over the erection and maintenance of overhead wires.

The Society of Telegraph Engineers and Electricians.—On Thursday next, at 25, Great George Street, the following papers will be read:—1. "On the theory of alternating currents, particularly in reference to two alternate current machines connected to the same circuit," by J. Hopkinson, F.R.S., Member. 2. "An account of experiments with alternate current machines," by Professor W. Grylls Adams, F.R.S., President.

The American Electrical Exhibition.—The exhibition to be held in Boston from November 5th to January 3rd, 1885, will include the following sections:—The production of electricity, electric conductors, measurement, application of electricity (high power), application of electricity (low power), terrestrial physics, historical apparatus, special novelties, and electrical literature. It is intended to make the exhibition complete and comprehensive in every particular, and to exceed in novelty any that has ever been held in New England.

Electricity Without Motive Power.—Last week, at the Manchester County Police Court, Samuel Harrison, a middle-aged man, of Gorton, was committed for trial on a charge of obtaining £180 by false pretences from James Edward Frith, a baker, who said the prisoner had completely deceived him by representing that he had patented an invention for producing electric light without any engine or motive power, which would run tramcars and drive engines, and could be put in a meter and turned on like gas. The evidence betrayed extraordinary credulity on the part of Frith and others.

Electro-Magnetism for the Cure of Diseases.—A "Society for the Extension of the True Electro-Magnetic Cure of Disease" has been formed, one of the objects being to establish in London, and elsewhere, hospitals where sufferers, especially the poor, may be provided with electro-magnetic machines and suitable attendance. The *patients* in these establishments will have our sympathy.

Electrical Engineers' Catalogue.—Following the example of other enterprising manufacturers, Messrs. A. R. Sennett & Co., electrical engineers, of Hatton Garden, have heightened the value of their catalogue by including interesting descriptions and explanations of the various requisites for an installation of electric lighting.

Gas Engines.—A reprint from the *Mechanical World* of the articles on "Gas Engines: their theory and construction," by Mr. C. F. Budenberg, B.Sc., has been forwarded to us. It appears to be a most complete history and description of gas motors.

Processes of Gold Extraction.—The paper on "Some modern processes of gold extraction," read by Mr. Rowland J. Atcherley, Ph.D., F.C.S., before the Balloon Society on October 31st, has been printed and published in pamphlet form. The treatise is interesting, and the latter part deals with the most recent methods of extracting the precious metal from its ores by means of electricity.

Trial Trip of the "Mackay-Bennett."—This steamer, which has been built by Messrs. John Elder & Co., at Fairfield Works, expressly to serve as a cable-repairing ship for the Commercial Cable Company, made her trial trip on Friday week in very stormy weather. The trial was in every way satisfactory to the officials who were present on behalf of the company. The bow and stern paying-out and picking-up gear were constructed and fitted up on board by Messrs. Elder for Messrs. Siemens Brothers & Co., to whose works in London the *Mackay-Bennett* proceeded on Saturday to receive her cable, electric apparatus, &c. The *Mackay-Bennett* was built under the special superintendence of Mr. St. Clare Byrne, of Liverpool.

Death from Lightning.—At a recent congress of German medical men, held at Magdeburg, a paper was read on the effects of lightning stroke on human beings, and the author showed that when the lightning discharge passed through the skin its passage was much easier, that is to say the internal organs are much more conductive than the epidermis. This fact, says *Engineering*, was pretty well known, but it is not so well known that the brain and spinal cord are apparently conductors, and hence a lightning stroke on the head does not materially injure the brain beyond shattering the nerves, and causing temporary derangement. Most persons struck by lightning do not remember anything about the stroke; but others describe a sensation such as would be caused by their being struck a heavy blow, and some have likened the shock to what they would be supposed to feel if torn into small pieces.

Prevention of Railway Accidents.—A Swedish engineer has perfected an invention for preventing railway accidents at points and swing bridges by means of an electrical machine placed in the telegraph office of the station, and connected by wire with two bells on a pole at the points in question. The engine of the train is fitted with a spring disc, seven inches in diameter; this disc makes contact with the pole as the train passes, and the bells are thereby made to give warning to the driver of an approaching train or one following, and the passage of the train is indicated at the nearest station.

Fire at the Silvertown Telegraph Works.—On Monday morning, before daybreak, a fire broke out at the works of the India Rubber, Gutta Percha, and Telegraph Works Company, at Silvertown, and burned furiously for some hours. It originated in a rubber store, which was burned out, whilst the remainder of the building and its contents were damaged by fire and water. Two steamers and a manual engine were in attendance from the West Ham fire brigade station.

Capital Punishment by Electricity.—A bill has been introduced into the Vermont Legislature by the opponents of capital punishment by hanging, providing for the execution of murderers by electricity.

Proposed Electric Railroad over Brooklyn Bridge.—The Knight-Bentley Company has submitted a proposal to work the railroad on Brooklyn Bridge by electricity, the present cable system giving great dissatisfaction.

International Exhibition of Inventions.—The number of applications already sent in for next year's exhibition represent more than twice the available space.

Underground Telegraph Wires.—The Stafford Town Council has granted permission to the Post Office authorities to lay down pipes for telegraph purposes.

Engineers' Employment Register.—Mr. James P. Maginnis, M.I.M.E., has opened an employment register at 23, Queen Anne's Gate, Westminster, S.W., for the benefit of engineers and others requiring assistants; and also for engineers, works-managers, and draughtsmen requiring situations. The method pursued appears to be satisfactory, and the rates of commission charged on the first year's salary are moderate.

Transfer of Business.—In order to devote their attention more fully to the development of the electric light, telegraph and telephone, and electric signal business, Messrs. Paterson and Cooper, of 76, Little Britain, E.C., have disposed of that portion of their stock and business relating to educational, philosophical, and experimental apparatus to Messrs. J. T. Mayfield & Co., of 41, Queen Victoria Street.

Obituary.—We regret to record the death of Mr. Frederick John Smith, an occasional contributor to our columns, which occurred this week at Taunton, where he was highly esteemed for his munificent works.

Torpedo Warfare.—The 14-gun corvette *Pylades*, launched at Sheerness on Wednesday, is fitted with electric machinery for the discharge of torpedoes.

Paris Exhibition, 1885.—The International Exhibition of Manufactures and Processes at Paris will be opened on the 23rd of July, closing on the 23rd of November, next year. The Exhibition is under the patronage of the Minister of Commerce, the Minister of Public Instruction and Fine Arts, and the Minister of Public Works. It will be held at the Palais de l'Industrie, Champs Elysées, and is to include a science annexe and a fine art annexe. The London offices are at 1, Castle Street, Holborn, where applications for the remaining available space and all communications from British exhibitors should be addressed to Mr. Edmund Johnson, Commissaire Delégué.

Institute of Mechanical Engineers.—At the meeting of the members of this institute at Nottingham on Wednesday, Mr. Timmis, of London, read a paper on the application of electro-magnets to the working of railway points and signals, claiming that with the system he advocated the distance of the signals from the box was immaterial. The cost was slight, the chance of error was avoided, and an infallible check could be obtained as to the working of the magnet.

The "Great Eastern."—The syndicate which on behalf of the Commissioners of the New Orleans Exhibition has chartered the *Great Eastern* steamer, took possession of the vessel at Milford Haven on Thursday. It is proposed to engage a crew of about 300 men, and Captain Halpin, who formerly commanded the great steamer, will probably again take charge of her.

NEW COMPANY REGISTERED.

Primary Battery Company, Limited. — Capital £6,300, in £5 shares. Registered office, 12, Princes Street, Hanover Square. Objects: To adopt two agreements, dated respectively 16th July and 22nd of August, between Thomas John Jones and Desmond Gerald Fitzgerald, of the first part, David Armytage Davis, of the second part, and Josiah G. Stapleton, of the third part; and to produce and supply electric light and power by means of primary batteries. Signatories (with 1 share each), *T. J. Jones, telegraph engineer; W. Ninnis Tiddy, telegraph engineer, and D. D. A. Davis, of 12, Princes Street, Hanover Square; *J. Gloch Stapleton, 47, Lee Terrace, S.E.; *W. Arbuthnot, 15, York Buildings, Adelphi; D. G. Fitzgerald, electrician, 6, Akerman Road, Brixton. Qualification for future directors: 70 shares, or £350 stock. The company in general meeting will appoint the remuneration of the board. Registered 30th ult., by Walls, Abbott & Martin, 11, Queen Victoria Street.

* Signatories whose names are preceded by an asterisk are also directors.

Change of Office.—The registered offices of Edison's Indian and Colonial Electric Company, Limited and Reduced, are now situated at 3, Great Winchester Street, S.E.

CITY NOTES, REPORTS, MEETINGS, &c.

Brazilian Submarine Telegraph Company, Limited.

THE 22nd half-yearly meeting of this company was held at Cannon Street Hotel on Friday, the 31st ult., the Right Hon. Viscount Monck presiding. The directors' report was given in the REVIEW of the 25th ult.

The Secretary, Mr. Richard Collett, having read the notice convening the meeting,

The Chairman said last year he was obliged to give rather a dismal account of their affairs; their cables were interrupted, their business was suspended, and their receipts were annihilated for the moment. He was very happy to tell them that on the present occasion he could completely reverse that picture. Their property in every respect was in an admirable state. They had a new cable laid, and the old cable was known to be in a good condition, not merely from scientific tests, but from actual inspection. Of the three breaks which had occurred in the old cable, they were entirely unable to account for the cause of one: the electricians had suggested that it might have been connected in some way with the extraordinary volcanic action which prevailed during the year 1883 all over the world, and they could see no other means of accounting for it. The other breaks had been occasioned in the usual way by abrasions in consequence of friction with a foul bottom. With regard to the income of the company, taking the six months from January to July, there were four weeks in March when the cable was suspended—that was before the second cable was completely laid—and of course there was a diminution of receipts during that period. Comparing with the similar period of the year before, and allowing to the period of suspension receipts equalling those of the weeks immediately succeeding, the income of the two periods was within £100 or £150 of the same amount. Taking the circumstances into account, he considered that this showed a growth in the receipts; because contemporaneously with the reduction of tariff there was competition for the carriage of messages to Chili and Peru by what was called the West Coast route, and their receipts having continued equal notwithstanding these disturbing circumstances, they might assume that there would have been an increase without them. The expenditure of the two half years showed an increase of £641 for the half year just passed; but in that expenditure was included the cost of the repair of the cable in March last, £760, so that in point of fact the expenditure was £120 less than the corresponding half-year. The general expenses in London showed a decrease of £227, and the working expenses at stations an increase of £172, due to the provision of new instruments. It was announced last year that they were about to duplicate the cable. He frankly confessed that he gave his adhesion to that policy with some misgivings; he was loth to sink in the sea the results of their reserve fund until it became necessary to have a second cable for the performance of their work. One cable was abundantly sufficient at the time, and therefore he was at first rather opposed to the duplication. However, he gave way to the arguments of his colleagues, and he was very glad now that he did so, for events had since entirely justified their policy. When he announced that they were about to duplicate the cable, he told them that they could not do it altogether by means of the reserve fund; he said they would require £250,000 in addition. If they looked at the report they would see that he greatly overstated the amount, as only £150,000 in addition to the reserve fund were required. He laid some stress on the point that they would be able to renew the cable without increasing their share capital. By increasing the share capital they would be introducing what was practically a permanent participant in their dividends, an element which must diminish their receipts in the dividends, and an element practically impossible to get rid of; but by raising the money by means of debentures they merely had a debt which they could pay off at some future period, and which would not be permanently operative in diminishing their receipts. He did not like to give too rose-coloured a description of affairs, but he hoped and believed that they would be able at least to pay the shareholders what they had been in the habit of receiving for the last four or five years, and that they might be able to make good any future breaks without either drawing on the debenture capital or raising a loan of any kind. He trusted that the mode in which the directors had managed the business during the last 12 or 13 years had been satisfactory. They began by giving a comparatively shall dividend, and when they found that they could safely do so they increased it to a larger amount; and they would go on in the same course, consulting not merely the temporary and fleeting interests of the shareholders, but the permanent and lasting good of the company. He moved that the report and accounts to the 30th June, 1884, be received and adopted, and that a dividend of 3s. per share, making, with interim dividends, a total of 6 per cent. for the year, free of income tax, be now declared.

Sir James Anderson seconded the motion.

Mr. Griffiths enquired as to the receipts of the last three months.

The Chairman said they had been very similar to those of the six months previously; they were almost identical with the corresponding three months of last year. There was a slight diminution, as in the other case, but at the same time the months of October, November, and December were the three best they had, and probably the average receipts of the six months would be superior to the average of the six months previously.

The resolution was then put and carried unanimously.

Sir Thomas Fairbairn and Mr. H. D. Gooch were re-elected directors, and the reappointment of Mr. Henry Dever and Mr. John Gane as auditors, at a remuneration of £50 each, was agreed to.

A vote of thanks to the Chairman and other directors terminated the proceedings.

Oriental Telephone Company, Limited.

THE directors of this company have issued a circular referring to a movement amongst a section of the shareholders which has for its object the appointment of a committee of investigation and a change of the directorate. The circular states:—

"Having reason to believe that the agitation is wholly actuated by feelings of animosity towards some of the members of the

board, the directors feel that they are justified in requesting the shareholders to withhold any promises of adhesion to any agitation until they have at least had an opportunity of hearing both sides of any question that has been or may be raised. The directors are ready to meet the shareholders whenever occasion arises. Meanwhile they are prepared to give every shareholder the fullest information they themselves possess, with perfectly free access to the records of the company. The revenues of the company and of its affiliated companies have materially improved since the last report, whilst the expenses have been considerably diminished;" and in conclusion cautions the shareholders against blindly sacrificing their property.

The Insulite Company, Limited.—A special meeting has been called for the 17th inst., for the purpose of confirming the following resolutions, which were passed at a previous meeting:—"1. That this company hereby adopts the agreement, dated October 22nd, 1884, made between this company, of the one part, and the British Insulite Company, Limited, of the other part, being the agreement mentioned in the notice of this meeting (dated October 10th) as providing for the transfer to the British Insulite Company, Limited, for the assumption by the last-named company of this company's assets and liabilities. 2. That it is hereby required that this company be wound up voluntarily."

Telegraph Construction and Maintenance Company, Limited.—Second Bonus Trust.—Coupon No. 19 on the certificates issued under the trust deed of the 12th March, 1875, at the rate of 1s. 4d. per £5 certificate (nominal value) is payable at the offices of Messrs. Barclay, Bevan & Co., No. 54, Lombard Street. Further supplementary sheets containing six coupons (numbered from 19 to 24) may be obtained by certificate holders upon production of their certificates at the offices of the company, 38, Old Broad Street, E.C.

The Eastern Telegraph Company, Limited.—This Company announces the payment of interest for the half-year ending 31st inst., on its 4 per cent. mortgage debenture stock.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of October was 2,588, estimated to produce £2,200, against 2,814 messages, producing £2,744 in the corresponding month of last year. The receipts for the month of July, estimated at £3,200, realised £3,219.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st October, are £2,468, as compared with £2,290 in the corresponding period of 1883. The July receipts, estimated at £5,865, realised £5,932.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 31st, were £2,934; after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company. The receipts for October, 1884, £26,600; and from 1st January to 31st October, 1884, £234,080; for the corresponding months of 1883, £215,235; and for 1882, £203,575.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of October, were £1,794, against £2,115 in the corresponding period of last year.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending October 31st were £4,065.

NEW PATENTS—1884.

14296. "Laying, carrying and insulating electric telegraph and telephone wires and electric light and power wires." J. C. SELLARS. Dated October 29.

14377. "Electric apparatus for recording the circulation of trains on railways." B. J. B. MILLS. (Communicated by C. Diener and C. A. Mayrhofer.) Dated October 30.

14445. "Galvanic batteries." W. R. LAKE. (Communicated by F. Kübmaier and J. Wannieck.) Dated October 31.

14448. "Electric arc lamps." G. C. FRICKER. Dated November 1.

14476. "Electric batteries," E. G. BREWER. (Communicated by J. Cerpaux.) Dated November 1. (*Complete.*)

14485. "Galvanic batteries." G. BARON DE OVERBECK. (Communicated by F. Horming.) Dated November 1.

14508. "Secondary batteries." A. H. REED. (Communicated by E. Commelin, G. Bailbache, A. L. de Virloy and L. de Bousignac.) Dated November 3.

14547. "Universal safety incandescence electric lamp holder." S. J. COXETER, H. NEHMER. Dated November 4.

14548. "Electric batteries or elements." P. M. JUSTICE. (Communicated by F. Van Rysselberghe.) Dated November 4.

14553. "Manufacture of carbons for incandescent electric lamps." G. DAVIDSON, R. C. JACKSON, J. B. DUNCAN. Dated November 4.

14560. "Galvanic battery for use in surgical operations, &c." H. J. HADDAN. (Communicated by Electrotechnische Agentur Richard Blänsdorf.) Dated November 4.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

90. "Improvements in electric block signalling instruments." W. E. LANGDON. Dated January 1. 6d. The object of this invention is to provide a more ready and more easily operated and secure means for pegging over or fixing in any required position the electric commutator handle or tapper by which the fixed signals, such as the "line blocked" or "line clear" signals, are produced. To this end the inventor provides, in the place of the pin employed for pegging the handle over as at present, a small key or thumb piece, which is fixed in the neighbourhood of the handle, either on one side of the same, immediately over it, or in other convenient position, a small key having two or more positions, one a position of rest, the other a locking position; or two positions for locking, one to lock to the "blocked" side, the other to lock to the "clear" side or position. This key is formed of such a shape that a part or extended portion shall, when the key is depressed in a certain position, engage with a fixed part of the instrument handle or commutator, or with a piece fixed thereon when the said instrument handle is held in the required position for affording the permanent signal. To release the key from this position it is merely necessary to raise it or press it in the opposite direction, that is, into its position of rest.

234. "Improvements in the manufacture of incandescent lamps." J. H. GARDINER. Dated January 1. 6d. The inventor winds the fibre or thread to form the filament, whilst in a moist and flexible state, upon a cylindrical block to a spiral form with two straight central ends projecting in opposite directions. The fibre or thread is kept tightly distended by springs until it sets in the spiral form. The block is made in two parts, which separate to release the spiral. The filament is carbonised in the usual way. It is then if necessary plated by igniting it in the presence of hydrocarbon vapour to adjust the resistance, and for this purpose its ends are held in clips supported upon a glass rod. The ends of the filament are then set into terminals. The terminal consists of a platinum wire armed at one end with a cup or tubular socket of a size to admit the extremity of the filament, and the other end of the wire is turned simply into a loop. The wire is coated spirally with glass, and for this purpose it is clamped in a mandril on which is a screw thread. The mandril can be revolved by a handle in a bearing, which also permits of longitudinal movement. A spring piece bearing on the screw thread limits the longitudinal movement to that due to the advance of the screw thread, except when the spring piece is pressed out of the way. The platinum terminal having been clamped centrally in the mandril is advanced by turning the handle between the points of two blow-pipe flames, one on either side. When the platinum is thus heated a thread of glass is wound upon it so as to cover it completely, the even distribution of the glass being ensured by the forward movement of the platinum wire whilst it rotates, and winds the glass upon it. Two terminals thus prepared are then clamped upon a holder with the required interval between them, and the ends of the filament are inserted into the platinum cups or sockets. A good junction is made by the application with a brush of a suitable paste or paint.

8443. "Improvements in electric arc lamps." C. LEVER. Dated May 30. 6d. This invention relates to improvements in the electric arc light apparatus described in the specification of a former patent granted to the inventor on the 3rd May, 1882, No. 2092, and is intended to accomplish the following objects:—1st. To enable the electric arc lamps constructed according to the said previous invention to be more effectively worked in single circuit from a series wound dynamo-electric machine than that described in the said previous patent specification, and also to combine with the improved device an arrangement of the parts which will "cut out" the lamp should the circuit through the carbons be broken. 2nd. To provide improved means of regulating the "dash pot" in the lamp whereby compensation can be made for the different viscosities of glycerine or other similar fluid which may be used in the said dash pot.

CORRESPONDENCE.

The Economics of Incandescence Lamps.

You ask, in your leader of the 1st inst., "which system is the more economical in the long run, that in which the electrical energy is reduced to $2\frac{1}{2}$ watts per candle-power, with a probable duration of 400 to 500 hours, or even less, as the life of the lamp, or that demanding $3\frac{1}{2}$ to 4 watts per candle-power, with the certainty of the lamp lasting 1,000 hours?"

Dr. Fleming pointed out to me, some years ago, that the value of an incandescent lamp is its $\frac{\text{candle-power} \times \text{life}}{\text{watts} \times \text{price}}$. The cost per hour for power and lamp renewals is therefore

$$n\,e\,c + \frac{p}{l}$$

where e is the number of watts per candle-power, n the cost of a watt-hour, c the candle-power, p the price of the lamp, and l the life of the lamp in hours.

It is evident that the relation between the important variables, e and l, depend on the external circumstances, n and p.

We may take, as extremes, ½d. and 1½d. for the cost of an electrical horse-power of 746 watts, and for the prices of lamps, 2s. 6d. to 7s. 6d. With a 20-C.P. lamp, taking 4 watts to the candle, the cost of power per hour, at ½d per H.P., is 0·0535d.; and at a price of 2s. 6d., and a life of 1,000 hours, the renewal cost per hour is 0·03d., making a total of 0·0835. But if, other things being the same, the efficiency is raised to 2½ watts per candle, the cost of power becomes 0·0335, and this, subtracted from the total, leaves 0·05d. for lamp renewal; this is equivalent to a life of 600 hours. An exactly similar result is obtained with power at the high rate of 1½d., with a lamp at 7s. 6d.

But with power at the high rate, and with a lamp at 2s. 6d., the life comes to 333 hours; that is if a lamp with 4 watts to the candle has a life of 1,000 hours, and an increase of efficiency from 4 to 2½ watts (or 60 per cent.) be obtained, the life may be decreased from 1,000 to 333 (or 66·6 per cent.), *without altering the total cost of the system*. And it follows, that if the lamp still has a life of 1,000 hours, it *is worth three* of the lamps of lower efficiency.

In short, if the lamp is very expensive, say 7s. 6d., and power may be had for a mere nothing, all our attention must be devoted to prolonging the life, the efficiency being nugatory; but if we could get lamps at a fair and reasonable price, say 9d., and were forced to use some extravagantly expensive source of power, such as a primary battery, we should strive to attain a high efficiency, the life being only a question of the trouble of replacing the dead lamps.

There is, however, an aspect of the question which is, in general, more interesting than the mere structural differences of the lamps, and it applies to the whole system of incandescence lighting. The efficiency of any given lamp varies as some function of the degree of incandescence, or actual candle-power; the life also varies inversely as some function of the same, and it is possible that these two functions are identical. Be that as it may, the important question then arises—at what degree of incandescence (determined preferably by the spectrum) should the lamp be run in order that $n\,e\,c + \frac{p}{l}$ may be a minimum?

It is most unfortunate that we are still practically without any authentic information on these points. It is true that it is a simple matter of measurement to determine the former, but then it is only good for one class of lamp, while time only will tell the life; and then where is a lamp running day after day at the same volts, and under regular conditions of work?

It appears, then, that under average conditions, if we can get a lamp taking 2 watts per candle, we ought to be satisfied (relatively) with a life of 600 to 700 hours; and when the time comes, and it should have come by this time, for a shilling lamp, a long life would be a question of convenience rather than economy.

With the present high prices, the value of lamps of high candle-power is most important, and appears to be strangely neglected.

A noticeable feature in the more efficient kinds of lamps is their colour; the filament is lost in a blaze of white light which puts to shame the "4 watt red-hot hair pins."

Alex. P. Trotter.

7, Furnival's Inn, London, E.C.,
November 4th, 1884.

The Electric Lighting Act.

I am anxious to get information relative to the cost of obtaining a license from the B. of T. under the Electric Lighting Act. I shall therefore be glad to know the names of any local authorities or companies who have obtained licenses under the above Act.

In my case the license is required by the local authority for the district, so that there will be no opposition to meet.

Ohm.

Glasgow, *November 4th*, 1884.

Telephones.

In reply to your correspondent "S. R's." letter in the REVIEW of 1st inst., I shall review the several communications by "S. R.," published in the REVIEW, in regard to the "Mechanic Receiver," and his statement on September 20th, that "the first definite intimation in England of the great discovery of Bell was published in the *English Mechanic* on 11th August, 1876." I now repeat my statement in the REVIEW of 11th October, "that the first definite intimation in England of what "S. R." is pleased to call "the great discovery of Bell," was published many months before that date, and I submit the following indubitable evidence in support of my assertion.

The *first* publication of Bell's invention, *subsequently* claimed by him to be a system and instrument for transmitting speech, was on 7th March, 1876, in the United States "Official Gazette of Patents" of that date, and also the publication on that date of the full specifications and drawings of Bell's patent, No. 174,465, for "Improvements in telegraphy." The "Official Gazette" contained a drawing of Bell's original gold-beater skin instrument, and a great number of that "Gazette" was received in England by many patent agents in the month of March, 1876, and this "Gazette" was on public view at the British Patent Office on 3rd July, 1876, as I stated in my letter in the REVIEW of 11th October. The fact that the "Gazette" was in the possession of many patent agents is such evidence of its publication in England that the claim for the invention described in it, and subsequently included in Morgan Brown's (Bell's) patent, necessitated the disclaimer by Morgan Brown on 13th February, 1878. I hope "S. R." will now be satisfied that I did not "mistake the force of the word definite," and that the FIRST definite intimation in England of the great discovery of Bell was *not* published in the *English Mechanic* of August 11th, 1876, but *was* published in England in the U. S. "Official Gazette" many months before that date.

"S. R." quotes from my letter in REVIEW of 25th ult., my statement that "the first notice of Bell's invention was on September 15th, 1876, in *Engineering*." That statement was in reply to your correspondent "S.," who in his letter in REVIEW of October 4th wrote, "W. C. B. is not correct in saying that Bell's telephone was described in *Engineering* prior to the patent being applied for in this country," and in the REVIEW of October 18th "S." wrote "the first notice and description of Bell's original instrument was not published till December 22nd, 1876."

I know full well that Bell's original invention had been published in the *English Mechanic* on 11th August, and in the U. S. "Official Gazette" long before that date, and my reply was intended to refer to the publication in *Engineering* of 15th September, not to the publication in other papers. It must be clear that I misplaced the words "in *Engineering*;" the sentence should read, "the first notice of Bell's invention in *Engineering* was on September 15th, 1876."

In the absence of *positive* evidence that the U. S. "Official Gazette of Patents" of 7th March, 1876, was received in England in March or April, 1876, by many patent agents, there is the fact that that Gazette, which contained a description of Bell's invention, namely the gold-beater skin instrument, was proved before Mr. Justice Fry in the case of the United Telephone Company *v.* H. Cox-Walker, by Mr. Alison, Librarian of British Patent Office, to have been on public view in that office on 3rd July, 1876.

"S. R." and "S.," and your readers generally, will find that the statements in my letters to the REVIEW are correct.

W. C. Barney.

November 3rd, 1884.

Van der Weyde's Telephonic Instruments.

In your notice of exhibits at the Philadelphia Electrical Exhibition, you have added a very interesting and important leaf to the history of the telephone, especially important in its bearing on the Bell patents in Great Britain as well as in the United States.

It is as clear as day that Van der Weyde's telephone instruments exhibited in the drawings, figs. 11 and 12, in the REVIEW are in principle, construction and mode of operation the same as Bell's improved telephone now in use by the United Telephone Company. The question, no doubt, will arise whether these instruments were known or described in any public newspaper or book circulated in England prior to the date of Bell's patent, namely, the 9th December, 1876. On referring to the REVIEW of February 16th, 1884, page 145, your readers will read the following words in a letter signed by me: "I am strongly inclined to believe that evidence is in existence, and can be produced, which will establish the fact that there was published in England, in 1869, the following description of a telephone receiver:—'An electro-magnet in front of a brass diaphragm with an iron button attached to the centre of the diaphragm.' The original instrument is at present in the possession of a friend, and it talks as well as any Bell telephone."

When I wrote that letter I had in my possession photographs of Van der Weyde's telephone, precisely like all the drawings in the REVIEW.

I had at that time a newspaper published in the United States in 1869, which contained a description of this instrument; and I now repeat that I am inclined to believe that the newspaper referred to was largely circulated in England in 1869; I withheld the name of the newspaper, its date and place of publication in the U. S., for reasons satisfactory to myself. I send you some extracts from an affidavit made by Mr. Van der Weyde in a suit now pending in the U. S. Court, which will, no doubt, be an interesting supplement to your notice.

The deponent states: "I have read the patent of A. G. Bell, No. 174,465, March 7th, 1876. I recognise in the devices, fig. 7 (the goldbeater skin with the iron bar armature), an instrument substantially the same in its electrical operation as the receiving instruments used by me in 1869 and 1870."

"I have also read the patent of A. G. Bell, No. 186,787, January 30th, 1877. The invention, as I understand the specification, consists chiefly in the substitution for the stretched membrane and armature of 'an iron or steel plate capable of being thrown into vibration by sounds made in its neighbourhood.'

"This modification conforms exactly to the telephone receiver which I used in 1869-70, that is, the combination with an electro-magnet of a plate of iron which can be thrown into vibration by the movement of surrounding air or by the attraction of a magnet." Fig. 11 and fig. 12 in the REVIEW show two forms of this receiver.

The deponent further says: "I notice that fig. 5 of the same patent is a drawing of a compound permanent magnet to the poles of which are affixed pole pieces of soft iron surrounded by helices of insulated wire, and that placing helices or coils on the end or ends of the poles of a magnet is claimed as a novelty in this patent."

"I know that placing coils upon the end or ends of the poles of a magnet is not original with Professor Bell. This magnet was described by me in the December number of the *Journal of the Franklin Institute* for 1861, where the illustration of it is found on page 420, and the description of its use for the production of currents identical to those obtained by Bell with his magneto-transmitter."

It follows that Morgan Brown's (Bell's) claim to the use of magnets with coils on the pole pieces is not valid because of the publication of such an instrument used for the same purposes* as Bell's in England in 1862—in the *Journal of the Franklin Institute* for 1861—and was on public view in the library of the British Patent Office in 1862, and is there at present.

I send you the official publication by the U. S. Patent Office of Bell's specification and drawings of his patent of January 30th, 1877, referred to Prof. Van der Weyde in his affidavits.

I send you a photograph representing another view of the instrument exhibited in your drawing No. 11, from which can be seen more clearly the identity of Bell's receiver as shown in his English patent, fig. 20, "a plate of thin steel attached to a frame," with that of Van der Weyde of 1869.

In my letter published in the REVIEW of 23rd February, 1884, I proved by Bell's own writings that he was well acquainted with Philip Reis's telephone instruments, and that he was not an *inventor* of a telephone, but a mere adaptor and improver of the Reis instruments.

Can anyone possessed of ordinary common sense believe that Prof. Bell was not well acquainted with the instruments used by Van der Weyde at a public lecture, and described in a daily newspaper, especially as at that time Prof. Bell says he was greatly interested in his studies in regard to the transmission of words by electricity.

W. C. Barney.

November 3rd, 1884.

[* We fear this statement may mislead. The publication mentioned contains descriptions of four new magneto-electric machines, and the one more particularly referred to was intended to prove the correctness of the principle that the coil may be advantageously wound round the steel magnets. It consists of a permanent horseshoe magnet with a coil on either pole, in front of which is a revolving armature, in shape like the customary keeper. There is no reference whatever to the machine as a transmitter of sound, whether articulate or otherwise, and we do not see that it could be considered in any way as invalidating the Bell patent.

The photograph sent by Mr. Barney represents a perspective view of the instrument, fig. 11, illustrated in our last week's issue. We do not think it shows the vital portions of the apparatus so clearly as that already published. The drawing of the Bell instrument to which Mr. Barney alludes can be found in the ELECTRICAL REVIEW for February 25th, 1882, page 146.—EDS. ELEC. REV.]

Information Required.

Two dynamos, A and B, and an electro-dynamometer are joined in one circuit. If A is put in motion by a steam engine, the currents generated in A will cause the dynamometer to deviate, and the dynamo, B, to rotate. If the movement of A is accelerated, B, too, will run faster.

I think I have read somewhere that in that case *the readings of the dynamometer still remain the same*, whatever the speed of the dynamos may be, owing, of course, to the counter-electromotive force generated in B. Can you, or any of your readers, tell me where I can have found this, and where I can find the mathematical or experimental proof?

T. W. G.

Delft, *November 1st*, 1884.

Duplex and Quadruplex Telegraphy.

Your correspondent "Electricista," in the postscript to his letter contained in your last issue, asks whether the manufacture for sale of sets of duplex telegraphs on either Bridge or differential systems for *educational purposes* or otherwise would constitute an infringement of any patent controlling duplex telegraphy? I regret that I am unable to give a full answer to his inquiry. I may mention, however, that the only cases in which the manufacture of a patented article does *not* constitute an infringement of a patent is when the article is made simply as an amusement or as a model, or for the purpose of *bonâ fide* experiment or where no commercial profit is derived from the use thereof, all of which cases, I apprehend, are without the pale of your correspondent's inquiry.

Thos. J. Handford.

42, Southampton Buildings,
November 3rd.

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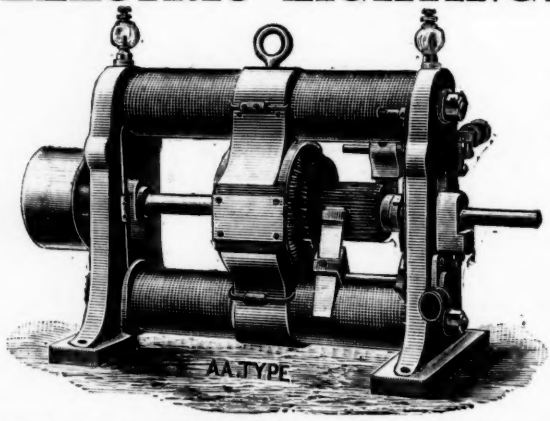

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VOL. XV.—NO. 363.

ELECTRIC LIGHTING FOR STEAMSHIPS.

AMONGST those who have rendered good service in advancing the interests of the electric lighting industry by advocating its claims in an intelligent and practical manner, the name of Principal Jamieson should certainly be prominently mentioned for the efforts he has made to bring forward the question of ship-lighting. His latest contribution to the information we possess respecting the feasibility of applying electricity to the illumination of steamships, is in the form of a paper read before the Institution of Civil Engineers last Tuesday, in which he says that, although it is not more than three years since the first application of incandescent electric lighting to the general illumination of steamships, the advantages accruing from the light have been so fully recognised that already more than 150 ships have been fitted with it, and scarcely a man-of-war or first-class passenger steamer of importance now leaves the builder's hands without having it on board. In speaking of the best position for a dynamo on board ship, Mr. Jamieson says that where practicable the axes of dynamos with large, heavy armatures should be placed fore and aft, to obviate as much as possible the effects of gyrostatic action, since the angular velocity due to rolling is greatest athwartship. In dynamos where the weight of the armature, its velocity and radius of gyration, are small, gyrostatic effects will not produce any appreciable increase of pressure on the bearings, whatever the position of the dynamo. Further on in his paper, the lecturer discoursed of dynamos and how to select them, explaining the Siemens, Edison, Victoria, Ferranti and Pilsen-Schuckert machines as arranged for use on board ship.

As the success or failure of an installation depends very much upon the engine used as a prime mover, Mr. Jamieson devoted special attention to the consideration of this subject; and he claimed that one of the most important adjuncts to the engine is the governor, which should be sufficiently sensitive and reliable in action to keep the engine within 5 per cent. of its normal speed, with a load varying 90 per cent., and a boiler-pressure varying 10 lbs. per square inch. No mechanical governor will do this, and consequently great vigilance has to be exercised on the part of the attendant. Mr. Jamieson recently heard of a case in which 50 of the 200 Swan lamps on board a large passenger-steamer were suddenly broken through a failure of the governor. The lecturer stated that a good electrical governor, which shall automatically open and close the throttle-valve, in perfect synchronism with the load, or work to be done, and leave the valve in its last position until a change is made either in the load or in the steam-pressure, is greatly to be desired.

Having entered minutely into the various methods adopted for driving dynamos, such as with leather belts, cotton ropes, direct-driving engines, and the rolling contact or frictional driving gear of Messrs. Siemens Bros., Mr. Jamieson reached a very important point of his subject, viz., the system of leading wires and their sizes, insulation-resistance, &c. This is a subject which has been brought forward on many occasions in our columns, and it may not be amiss to quote a few of Mr. Jamieson's comments. After pointing out the advantages and disadvantages of the single and double wire systems, he says it is most important that the size of the conductor should be sufficient to carry the necessary current without causing more than 4 to 5 per cent. loss of electrical power developed in heating them, and that the insulation-resistance of the whole circuit when fitted, including all switches, &c., must not be less than 1,000 ohms per volt of electromotive force generated by the dynamo. Before fitting the wires, specimens of not less than 100 feet should be selected, immersed in sea water or brine-water for twenty-four hours, and then carefully tested for insulation-resistance, and not passed unless they give over 10 megohms. Specimen joints should be treated in the same way, and give at least 100 megohms each. It is seldom that on board ship more than 300 ampères are generated by any single dynamo; and as several main leads usually spring from the dynamo-room to various parts of the ship, the current in any one of them seldom exceeds 100 amperes, so the wires do not vary greatly in size, and generally four sizes will suffice for a ship.

We have over and over again enforced upon electric light engineers the necessity of paying the utmost attention to the matter of insulation resistance. Mr. Jamieson finds, as we have always suspected, that in the case of electric lighting those who are charged with the fitting up of an installation very seldom think of taking, or even know how to take, insulation tests, either of the dynamo or the leading wires. The professor himself has found great difficulty, in most installations with which he has been connected, to get the contractor to recognise the importance of this test; in fact, he has only met with one instance in which the contractor himself used testing apparatus which would detect a small flaw in the insulation of the wires after they had been fitted. To this general neglect of testing conductor-insulation and resistance may be attributed some of the failures that have occurred. As we have oftentimes stated, and as Mr. Jamieson himself expressly remarks, the insulation-resistance standard need not be nearly so high as in the case of submarine cables, but nevertheless it does require to be several hundred times more than the copper resistance, otherwise a fault will soon develop, the lead break down, and short-circuit under the combined influence of the currents and electromotive force used and damp or wet.

The excellent and highly practical paper concluded with some observations on switches, fusible junctions, lamp holders, lanterns, globes, &c., and a reference to arc lamps on board ship.

Mr. Jamieson's closing remarks, in which he quoted Mr. Preece, will form an appropriate termination to

our comments :—" It cannot be too strongly urged that specification without rigid inspection is valueless. . . . Many administrations object to the expense of thorough inspection, and the result is they are recipients of the rejected material of those who do rigidly inspect."

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—MONTREAL, 1884.

ON THE SEAT OF THE ELECTROMOTIVE FORCE IN THE VOLTAIC CELL.

By Prof. OLIVER J. LODGE.

(*Specially reported for the "Electrical Review."*)

(*Continued from page* 361.)

In volume 12 of Wiedemann's "Annalen," I find some interesting experiments by Schultzeberge on contact force between metals and gases. He uses a condenser in different gases, but the plates of his condenser are of the same metal. He coats one of the condensers with a film of gas, say, chlorine, or hydrogen, or ozone, and leaves the other covered with air. To measure the potential difference, he employed the compensation method of Pellat. His arrangement seems sensitive and satisfactory. Putting his plates under an air pump he obtained an effect; but he was cautious enough to repeat the experiment by leaving the plates under the bell jar and not exhausting, He obtained the same effect, and attributes it to grease perhaps. This is the right sort of way to make experiments, and if everybody experimented with proper care there would be vastly fewer papers published in Germany, and science would progress, on the whole, faster. At present it seems to me overladen with a mass of publications mostly, of necessity, by men of not absolutely the first order, much of it with no sort of clearness or insight, but rough, crude, and ill-digested. A man makes a number of experiments; he does not stop to critically examine and weigh them, and deduce from them their meaning, nor, indeed, does he even take the trouble to examine whether any definite meaning can in their then shape be drawn from them; but he rushes with them into print, producing a memoir of wearisome length and sometimes extreme illiterateness of style. Some one else, then, has the trouble of wading through the heap to see if any fragments of truth may perchance be embedded in it, and probably he is unable to come to any definite conclusion, because he cannot be in such a good condition for criticism as the original author was. He therefore writes a paper pointing out the defects and errors in the communication. Others take up the same line. The original man replies, and so there is a controversy and nothing is really settled at all. Finally, some one else independently goes over the whole ground from some distinct point of view, makes a few well-planned, clear and decisive experiments, describes them in a compact and readable form, and there results a definite gain to science. But how much better it would have been if this last paper had been the only one published. Unless a man is an experimental genius of the highest order, it is necessary for him to think for far more time than he experiments, if he wishes to advance, not to lumber his science. If it be objected, as indeed it may with great truth be, that one man's life and capacity are not sufficient for this in the present state of knowledge, the objection constitutes a strong argument in favour of the proposition that the time has come for the organisation of science and a more definite division of labour.

To return however to the experiments of Herr Schultzeberge and to the result he obtained. His main experiment consisted in using a condenser with both plates of the same metal, but one contact with a film of gas, the other of air. Tried thus, ozone rendered air Au. Pt. and brass negative as against the corresponding air covered plate. Hydrogen rendered its platinum strongly positive, but its influence on gold was slight, and on brass uncertain. Chlorine and bromine made the platinum negative, and ammonia made brass positive. It was not easy to make quantitative experiments which agreed with each other, but he gives H. Pt. against air. Pt. about ½ volt, and also gives other numbers. The only conclusion he draws from the experiment is the tolerably safe one, that the contact force between metal and gas is not necessarily the same as between metal and air. The extraordinary thing however is that some apparently equally good experiments previously made with the same method by Pellat had resulted in a conclusion that a condenser made of two different metals showed nearly the same volta effect whether the atmosphere surrounding the plates was air or hydrogen. I am unable to reconcile the discrepancy except by suggesting that perhaps Pellat did not take sufficient pains to remove the air originally in his bell jar and on both his plates.

Perhaps this is now the place to refer to the extraordinary and most erratic series of papers by Professor Franz Exner. He sets himself to dispose the existence of contact forces in the most straightforward and obvious manner and to establish the fact that there is no electrical evolution without definite and actual chemical action. To this end he announces the following propositions: First, that two metals in a chemically indifferent medium show no electricity. Second, that the potential difference of two connected metals in air is exactly twice the difference of their heat combustion energy. Third, that two pieces of the same metal produce contact electricity so soon as they are put into chemically different atmospheres. The experiments by which he supports these assertions have been elaborately and severely criticised by Beetz, Hoorweg, Schultzeberge, von Zahn, Ayrton and Perry and Wiedemann and his numerical determinations of contact force appear to be unique. It is not necessary for me to enter into a discussion on the merits of his experiments inasmuch as the mere fact of so great a body of hostile opinion is sufficient to show that they were not of a kind best qualified to produce conviction. The theoretical views which led Prof. Exner to formulate his second statement above that the potential difference of two connected metals is equal to twice their heat combustion per equivalent, is I am sorry to say quite unintelligible to me. They depend on the hypothetically necessary existence of films of oxide, between which and the metal there is supposed to be a considerable difference of potential. He has got hold of the notion that the heat of combustion has some sort of relation to the volta effect, and there I am heterodox enough to agree with him, but what the relation is and how it acts and what sort of potential difference you ought to expect in accordance with theory, concerning all these things I am utterly at variance with him, and I deem it prudent not to attempt to represent views which I am unable to understand because it is not likely that I should do them justice. Prof. Exner to strengthen his position adduces a large number of very simple experiments (such as connecting first one Daniell and then two Daniells to an electrometer and observing that in the second case the deflection is double the first): and from these he obtains equations algebraically representing that Zn / Cu = 0. Considered as conundrums

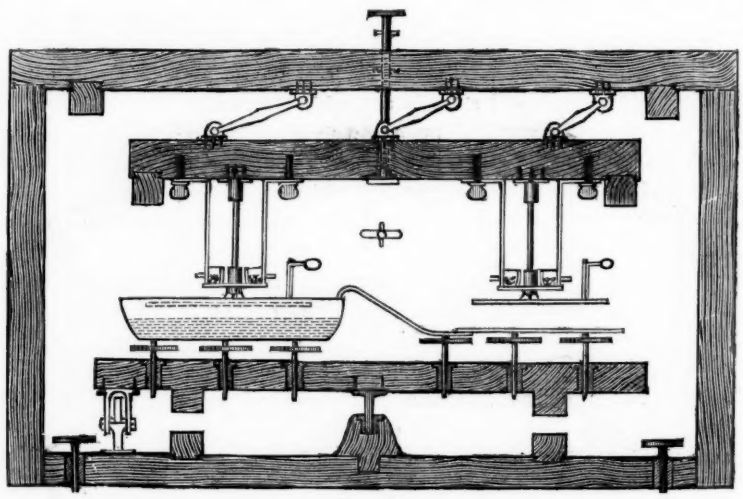


FIG. 7.

Ayrton and Perry's apparatus for observing and measuring the volta effect for all manner of substances, by a sort of Kohlrausch method; the plates being raised, rotated till reversed, then lowered again and put in connection with an electrometer.

these equations are ingenious, but it is a waste of time seriously to discuss them, as Herr Julius has done in an elaborate manner. To suppose that such every day experiments as these are in direct contradiction to the contact theory, is scarcely complimentary to the great men who have held, and who still hold that view. There are one or two minor papers to which I may refer before closing this historical sketch of what has been done in the subject of the volta effect, for instance that by Dr. G. C. Knott and by Mr. Lavington Hart, but there is hardly time.

The result of this survey in regard to our special subject of discussion may now be summed up. 1st. There is certainly an E.M.F. at the junction of two different substances or even of the same substances in two different states; and secondly, the total E.M.F. of a circuit is the algebraic sum of all such contact forces at every junction in the circuit. I do not know that these two propositions could be passed *nem. con.*, but I believe that, provided they are properly understood, the dissenting minority would be a very small one. It is probable that Prof. Exner would be in the minority, but I am unable to be sure of anyone else. We can also make a negative proposition which will command almost universal assent, namely, that if in the above second proposition, instead of the sum of the contact forces at *every* junction, we attend only to the contact forces at the *metallic* junctions, the proposition will no longer be true. This fact, that the metallic junctions are insufficient to account for all the E.M.F., was established completely by Becquerel and De la Rive, and then, and still more completely and exhaustively, by Faraday. It is the easiest possible thing to make any number of batteries which shall give a current without any metallic junction whatever. So much being agreed to, what remains as subject matter for controversy? This: a voltaic current contains at least three junctions. What is the value of the contact force at each of these, and especially, to which junction is the major part of the observed E.M.F. due? Is it the zinc acid, or is it the copper acid, or is it the zinc-copper? There is no other question. The old chemical and contact controversies have died out; but another controversy remains. Most persons would say to-day, that the major part of the E.M.F. of the cell resides at the zinc-copper junction. This was Volta's view; and this is the view taken by the text book writers taught by Sir Wm. Thomson. A few persons would say, "At the zinc acid junction," and amongst them I must confess myself. It is no question between contact and something else; it is a question between a feeble energy-less metal-metal contact, and an active energetic metal-fluid contact, with potentialities of chemical action straining across the junction.

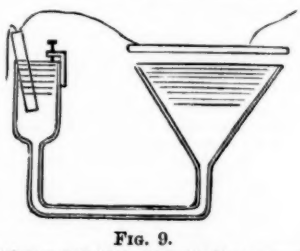


FIG. 9.

Hankel's modification of Kohlrausch's method for measuring the volta force between metals and liquids.

What is there to distinguish between the two? Electrostatic experiments with air condensers prove nothing. They add up three E.M.F.s: air/M + M/M^1 + M^1/air, and give you the sum. The experimenter assumes that M/M^1 is what he is measuring; but there is no proof to be given in support of the assumption, except that if you substitute water for air the effect remains almost unaltered; but then water contains oxygen as an active element, the same as air does. Well, then, the effect is the same *in vacuo*, and in hydrogen, to which I answer: "Not proven."

Can any further assertion be made with reference to electroscopic experiments as supporting a Voltaic theory? Yes; it can be asserted that by adding up the Volta effects, obtained by experiment, upon open circuits, you get the total E.M.F. for a closed circuit. But what then? What you call A/B is really

air/A + A/B + B/air

what you call B/C is

air/B + B/C + C/air

. . . . . .

and what you call Z/A is

. . . . . .

air/Z + Z/A + A/air

Add them up, and you get A/B + B/C + ... + Z/A,

which must be the E.M.F. of a circuit by common sense, that is without violent experimental disproof, which no one has ever attempted to give. This fact that the sum of the Volta effects equals the sum of the true forces in a closed circuit of any materials has, nevertheless, caused persons to suppose that the air-metal force was negligibly small. They may have any value they like without affecting the truth of the case. The only way they could affect it is for air/M not to be equal to − M/air.

Leaving electrostatic determinations as without bearing on the point at issue, let us ask, is there no direct and straightforward way of measuring the actual E.M.F. at a particular junction without disturbance from other junctions? The answer is most clearly given by Maxwell thus: "Sir Wm. Thomson has shown that if π is the coefficient of the Peltier effect, or the heat absorbed at its junction by unit current in unit time, then $J\pi$ is the E.M.F. at that junction acting with the current. This is of great importance, because it is the only method of measuring a local E.M.F., the ordinary method of joining up by wires to an electrometer being useless. This Peltier measurement is quite independent of the effect of contact forces in other parts of the circuit; but this E.M.F. does not account for Volta's force, which is far greater and often opposite. Hence the assumption that the potential of a metal must be measured by that of the air in contact with it must be erroneous, and the greater part of Volta's E.M.F. must be sought, not at the junction of two metals but at one or both of the surfaces which separate the metals from the air, or other medium, which forms the third element in the circuit."

And in another place he says: "In a voltaic circuit, the sum of the electromotive forces from zinc to the electrolyte, from the electrolyte to copper, and from copper to zinc, is not zero, but is what is called the electomotive force of the circuit—a measureable quantity. Of these three electromotive forces, only one can be separately measured by a legitimate process, that, namely, from copper to zinc. If we cause an electric current to pass from copper to zinc, the heat generated in the conductor per unit of electricity is a measure of the work done by the current per unit of electricity, for no chemical or other change is effected. Part of this heat arises from the work done in overcoming ordinary resistance within the copper and the zinc. This part may be diminished indefinitely by letting the electricity pass very slowly. The remainder of the heat arises from the work done in overcoming the electromotive force from the zinc to the copper, and the amount of this heat per unit of electricity is a measure

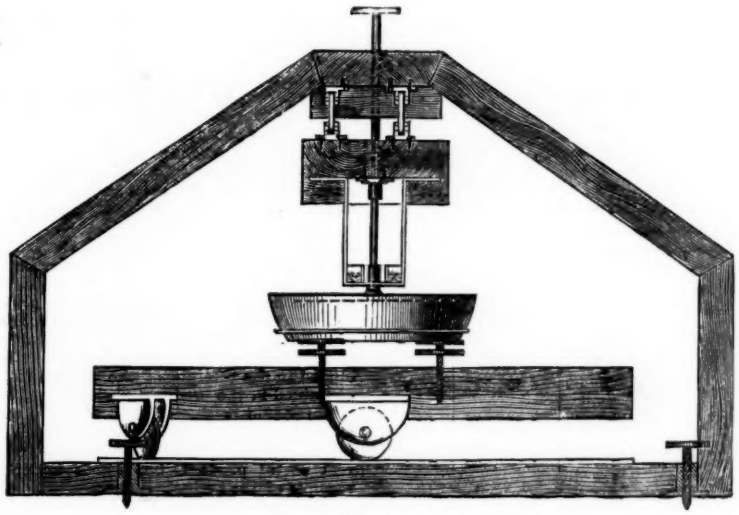


FIG. 8.

Ayrton and Perry's apparatus: end view.

of this electromotive force. Now, it is found by thermo-electric experiments that this electromotive force is exceedingly small at ordinary temperatures, being less than a microvolt, and that it is from zinc to copper. Hence the statement deduced from experiments in which air is the third medium, that the electromotive force from copper to zinc is 0·75 volts, cannot be correct. In fact, what is really measured is the difference between the potential in air near the surface of copper, and the potential in air near the surface of zinc, the zinc and copper being in contact. The number 0·75 is therefore the electromotive force, in volts, of the circuit copper, zinc, air, copper, and is the sum of three electromotive forces, one only of which has as yet been measured."

With every word of Maxwell I cordially agree, and I shall not inflict upon the meeting any more of my own ideas at present.

(To be continued.)

THE ORGANISATION OF THE POST AND TELEGRAPH SERVICE IN FRANCE.

(*Continued from page* 290.)

THE lowering of the rates, of course, caused a falling off in the receipts. The committee of supply estimated that the losses on the estimated products of the postal service for 1878 would amount:—

For the first year to ...	...	18,000,000 francs
„ second year to	...	12,000,000 „
„ third year to	...	4,800,000 „

This estimate was even considerably lower than the estimates and calculations of special officials.

The committee thought that it would not be until in the fourth year from the date of the reforms that we would obtain receipts equal to the original estimates of receipts for 1878, made out according to the old tariffs.

As regards the telegraph receipts, the committee of supply expected a loss of not more than 1,200,000 francs, applicable only to the first year of the reform.

The following table shows the results of the postal and telegraph reform per year, starting from the 1st of May, 1878:—

Year of Reform.	Products.	Corrected estimates of the Committee of Supply.	Excess of the products over the estimates.	
POSTS.				
				Per cent
1st May, 1878, till 30th April, 1879 -	100,497,717	95,876,000	4,621,717	4·82
1st May, 1879, till 30th April, 1880 -	106,538,855	101,876,000	4,622,855	4·54
1st May, 1880, till 30th April, 1881 -	116,533,709	109,076,000	7,457,709	6·84
TELEGRAPHS.				
1st May, 1878, till 30th April, 1879 -	21,473,507	16,217,000	5,256,507	32·41
1st May, 1879, till 30th April, 1880 -	24,199,997	17,417,000	6,782,977	38·94
1st May, 1880, till 30th April, 1881 -	26,592,201	17,417,000	9,175,201	52·68
POSTS AND TELEGRAPHS.				
1st May, 1878, till 30th April, 1879 -	121,971,224	112,093,000	9,878,224	8·81
1st May, 1879, till 30th April, 1880 -	130,738,832	119,293,000	11,445,832	9·59
1st May, 1880, till 30th April, 1881 -	143,125,910	126,493,000	16,632,910	13·15

If, instead of examining the results obtained each year of reform, we were to seek what were the consequences of this lowering of rates on the annual budgets, we should have to add to the expenditure during the financial years the losses foreseen by the committee of supply for the first three years of the reform.

This would give us the following distribution:—

	Posts. Francs.	Telegraphs. Francs.
Estimate, 1878 (eight months of the first year of reform), loss	12,000,000	800,000
Estimate, 1879 (four months of the first and eight months of the 2nd year of reform), loss	14,000,000	400,000
Estimate, 1880 (four months of the second and eight months of the third year of reform), loss	7,200,000	...
Estimate, 1881 (four months of the third year of reform), loss	1,600,000	...
Totals	34,800,000	1,200,000

The following table shows, per financial year, the surplus of the receipts over the estimates:—

Years.	Posts.	Telegraphs.	Grand total of the products.	Estimates.	Excess of the products over the estimates.	
						pr. cent
Original estimates of 1878	113,876,000	18,882,000	132,758,000	..	..	..
Products of 1877	119,521,077	19,678,438	139,199,515	..	..	..
„ „ 1878	102,355,650	21,204,627	123,560,277	119,958,000	3,602,277	3
„ „ 1879	104,715,588	22,913,939	127,627,527	118,538,000	9,289,527	7·83
„ „ 1880	112,687,493	25,612,426	138,299,919	126,658,000	11,641,919	9·19
„ „ 1881	123,638,575	29,193,916	152,832,491	131,158,000	21,674,491	16·53
„ „ 1882	126,333,010	28,219,630	154,552,640	132,758,000	21,794,640	16·42
„ „ 1883	132,158,000	28,936,000	161,094,000	132,758,000	28,336,000	21·44

If we compare the products of each of the years 1878 to 1883 with those of the preceding year, we obtain the following results:—Products of 1878—123,560,277 francs; products of 1879—127,627,527 francs, or an increase of 4,067,250 francs over the year 1878; products of 1880—138,299,919 francs, or an increase of 10,672,392 francs over the year 1879; products of 1881—152,832,491 francs, or an increase of 14,532,572 francs over the year 1880; products of 1882—154,552,640 francs, or an increase of 1,720,149 francs over the year 1881; products of 1883—161,094,000 francs, or an increase of 6,541,360 francs over the year 1882. These facts have thus given figures, which are considerably higher than the estimates.

Since 1880 we have reached the level of the receipts of 1877; in 1883 we have exceeded it by twenty-two millions. Up till 1870 the net product of the posts and telegraphs together has fluctuated at about twenty millions. It amounted to 20,438,601 francs in 1860. During the following years it became nineteen millions and eighteen millions, then decreased to sixteen millions in 1864, and not till 1867 did it amount to 21,996,768 francs, whilst in 1869 it was as high as 27,529,754 francs.

When, after the events of 1871, the rates were increased, the net product immediately ran up to thirty-six millions.

During the two or three last years previous to the reform, the figure of the net products amounted even to over forty millions.

In order to be able to compare the present net product with that of the years previous to 1879, the figures referring to the operations of those latter years should be increased:

1. With an expenditure of 45,000 francs, the amount of the credits previously attached to the Central Administration of Finances, which have been carried over to the budget of the posts and telegraphs, at the time of the creation of the Ministry, as belonging to the latter.

2. With a receipt of 571,149 francs, representing the reimbursements paid by the railway companies for the costs of superintending their telegraph service, and which, only since 1878, are included in the postal and telegraph products.

There should further be subtracted from these figures the sum of 279,077 francs, the amount of the rates referring to telegrams of Algerian origin, which, before Algeria was connected, was included in the receipts of the metropolis, and which at present is contained in the products of Algeria.

We should further observe that the receipts do not include the amount of the deposited money articles not claimed from the postal officials and forfeited to the Treasury, and which forms a real postal product, but comes under the heading of sundry receipts of the budget.

Taking these elements into account, we find that the net product of 1876 was 43,412,785 francs; that of 1877 amounted to 46,275,976 francs (not including an exceptional receipt of 1,200,000 francs proceeding from the carriage of newspapers and circulars during the time of the elections).

It was precisely because of this increase of the products that we thought it possible to reduce the tariffs. Moreover they are exceptional net products which had not served as basis for the making out of budgets. Indeed the projected budget of 1878, prepared before the reform, without any consideration of reducing the tariff, gave the receipts as equal to 132,187,260 francs, and the expenditure as equal to 91,941,632 francs. The net product, calculated on the same conditions as those of 1876 and 1877, amounts to 40,537,700 francs.

The simultaneous reduction of the telegraph rates which took place on the 1st May, 1878, of course, would involve a considerable falling off in the net product. This decrease could not be attenuated but by an increase of the traffic. This is what the Chambers had foreseen when they voted the reduction, and what the results have justified; this is indisputably proved by the figures we will give: a previous observation, however, is required. In order to make an exact estimate, the fact should be taken in account, that the budgets of 1881, 1882, 1883 and 1884 included new expenditures of an exceptional character, and which had not occurred in the previous years; therefore, in order to establish a just comparison, these expenditures should be deducted when making out the net product.

Thus the budget of 1881 was burdened with a sum of 429,042 francs, as part of the costs of establishing a new cable from Marseilles to Algiers, with 217,920 francs as part of the installation of the Works at Toulon, with 114,700 francs for the Exhibition of Electricity and the Congress of Electricians, with 425,840 francs for the settlement of treasury advances applicable to previous budgets; or a total of 1,187,562 francs.

In 1882 a new maritime service, voted by the Chambers for Australia and New Caledonia, involved a subvention of 461,922 francs (for the months of November and December); the expenditure for the Congress of Electricians amounted to

48,766 francs; the Works at Toulon to 79,706 francs; or a total of 600,394 francs.

In 1883 the expenditure to be deducted to compare the net product with that of the previous years included 2,460,730 francs for the subvention of the service with Australia (a whole year); 1,700,000 francs for the cable to Senegal, voted at the request of the Ministry of Marine; 151,141 francs for the Conference of Electricians and the Exhibition in Vienna; or a total of 4,311,877 francs. By not taking in account these exceptional expenditures, as well as the receipts and expenditures of Algeria, which, only since 1881, are included in the budget of the posts and telegraphs, we obtain for the net products, compared with those of previous years, the following results.

Budget.	Receipts.	Expenditure.	Net Product.	Total Net Product.
1878...	123,281,200	97,646,730	25,634,170	25,634,170
1879...	127,334,102	105,303,604	22,030,498	22,030,498
1880...	138,055,323	106,925,867	31,129,456 + 302,500*	31,431,956
1881...	152,832,491	116,638,734	36,193,753 + 632,575*	36,826,328
1882...	154,552,640	123,431,597	31,121,043 + 880,000*	32,001,043
1883...	161,094,000	129,830,140	31,263,860 + 880,000*	32,143,860
1884...	166,408,000	132,515,815	33,892,185 + 880,000*	34,772,185

Thus the year 1878, from the first of May of which year new rates were applied, only gave a net product of 25,600,000 francs. For the year 1879, the whole of which was submitted to the regimen of the reduced rates, the net product dropped to 22,030,498 francs; the lowest figure since the reform. Since 1880, owing to the development of the traffic, it rose to 31,120,456 francs and in 1881 amounted to 36,826,338 francs, notwithstanding the improvements of all kinds introduced in the service, and the increase of the expenditure caused thereby.

The progression was affected by the crisis of 1882; but, as shown in the table, the increase of receipts over the preceding years went on. 1882 gives a slight augmentation over 1881, but the products of 1883 exceed by more than six millions those of 1882, and we are getting on to obtain a net product of 40 millions. When we have obtained that, the success of the reducing of the rates will be complete.

We shall have given to commercial transactions the advantage of reduced rates, on the whole by nearly one half, and, owing to this fertile reform, we shall have obtained such an increase of traffic that we approach the largest previous net products.

At the same time we have been able to introduce great improvements in the postal and telegraph service, especially in the interest of the staff; these improvements involved heavy expenses, which have also been compensated for by the increase of the receipts.

To appreciate, moreover, the share contributed by the posts and telegraphs to the general resources of the State, we should not forget that the subventions to the maritime services, which are of great national interest, but which cannot be called real postal expenses, are included to a considerable amount in the budget of the posts and telegraphs.

On the other hand, the service of posts and telegraphs carries free a large number of letters and transmits numerous official telegrams, which involve expenditure to the Administration, without being a source of receipts. Therefore, to obtain the true result of the working of the posts and telegraphs, we should have to increase the difference between receipts and expenditure with a sum which certainly would be very important, representing the rates of the free correspondences.

The introduction in France of the collecting of money by post offices for bills of exchange, receipts and commercial bills, had been asked for on various occasions. This service worked already successfully in Germany, Switzerland, and Belgium.

In 1879 the results of the reducing of rates were already known; the first measures required to strengthen the postal work had already been taken; the only thing to fear was, that, inaugurated at a moment when a considerable increase in correspondence would suddenly be produced, the new service might interfere with the various machinery of the Administration. Circumstances appeared to us favourable to satisfy the wishes of the public and to submit to the Chambers the result of careful considerations, by proposing to it to establish amongst us this collecting of money, which renders such services to, and has succeeded so well, with our neighbours.

It has not been our intention to enter into competition with private enterprise, but, on the contrary, to come to its aid wherever its means of action were insufficient; we wished to give to commercial transactions a new co-operation which the intervention of the post alone could obtain for them in a complete and general manner.

If the collecting of invoices and bills of certain importance could be done on reasonable conditions in towns, the expenses, however, became considerably higher when this referred to small sums, which had to be paid in certain rural parishes; the negotiation of such bills was therefore nearly impossible.

We knew, moreover, from the example of what goes on at our neighbours, that on this point the post was able to satisfy the wants of commerce.

The post, in fact, by having its offices distributed over all parts of the country, and by its letter carriers who pass every day through the smallest hamlets, possesses beforehand all the necessary means for carrying this out. Its devoted and industrious staff offers to the public the required guarantees of safety and efficiency. At the same time, by undertaking the duties of collecting money, it really does no more than extend the service of money matters, which of late years has become of considerable importance.

Constant practice, moreover, shows that the post is by nature designed to undertake the collecting of money. Before the post was officially charged with this work a large number of commercial houses and bankers already made use of our postmen in all localities, where it was impossible to do this otherwise, without sustaining considerable expenses.

We know from an enquiry, made in 1878, that the total amount of the sums thus collected by the letter-carriers was not less than 47 million francs. There were serious objections to allow of such important work being carried out in an irregular manner, beyond all control, and we have thought it prudent, without depriving commerce of the means of effecting these collections through the agency of the post, to put this service in better order, and to bring the postmen under the full responsibility and supervision of the Administration.

Prompted by what is done in the countries where the post undertakes the collecting of money, for invoices and bills of exchange, and after having considered the various systems now working, we have given our preference to that which has appeared to us to be the most simple, and which will introduce the least complication in the numerous books kept by the postal officials. This system is very similar to that which has been adopted in Germany, Switzerland, and in the relations between those two countries. The depositor himself inserts the bills, the amounts of which have to be collected in a registered letter addressed to the post office of the district in which the debtor resides.

This office is thus directly charged with the collecting of the money; the amount received, after deducting the rate, of which we shall speak later on, is changed by the postmaster into a post office order in the name of the depositor. Thus one office only is in reality charged with the collecting; the forwarding office has only to transact the ordinary work, viz., the sending of a registered letter and the cashing of a post office order.

The rates for each of these transactions are:—A registration fee of 25 centimes; a deduction of 5 centimes for every 20 francs in favour of each of the officials charged with the collecting (postmaster and letter-carrier), with a maximum of 25 centimes for each of them; and, finally, the rate for the post office order of one per cent. This manner of proceeding assures quickness in the transactions; only very little more work is thereby thrown upon the staff, and it avoids thus the increase of expenses which the deposit of bills without security would entail, and by which both the terminal offices participate in the work of collecting, and sometimes even the intermediate offices.

At the approach of the days of falling due, any obstructions at the counters of the offices, which is inconsistent with the quickness of postal work, is thereby avoided; at the same time, owing to the commission deducted from the total amount, both the postmaster and the postman charged with the receiving are interested in the success of the collections; they are certain of a remuneration in proportion to the service rendered, without charge, either to the Treasury or to the depositor.

The law of the 5th April, 1879, had contented itself with laying down the basis of the new organisation and determining the essential arrangements of it, leaving to the Government the power to extend it in a manner compatible with the difficulties of our work, should further developments appear to become necessary.

When an Administration, burdened as is the Postal Administration, adds a new load to its ordinary work, it is of course impossible from the very beginning to proceed in a general manner, and to create all at once a service which did not exist. It is necessary to grant it the power to organise it, and to extend it progressively.

In order to avoid the difficulties which the collecting of protestable bills could involve, the post ought to receive, in the beginning, only bills payable without costs. For the same reason we were authorised to organise the new service only successively, by taking in account local circumstances, and in such a way as to reconcile the work of the postal service proper with the new obligations to be imposed upon it.

At the beginning the post only undertook the collecting of bills, the total amount of which did not exceed 500 francs; but we had the power to increase this maximum later on, by means of decrees inserted in the *Bulletin des Lois*.

Making use of the freedom which the law granted us in this respect, we have hastened to extend and to complete the new service as soon as we have thought it possible to do so without interfering with the regular working of our department. Thus the decree of the 10th May, 1879, had temporarily excluded Corsica and 40 important towns, where some difficulties might have been met with at the beginning; since the 28th June of the same year, we have reduced to six the number of towns excluded from the benefit of this law; the decree of the 9th July following in doing away with the last exceptions, extended it to the whole territory of continental France and Corsica. Finally, a decree of

* The Amount of subventions paid since the 1st July, 1880, by the Department of Posts and Telegraphs for the maritime service with Algeria and which previously was paid by other departments.

the 31st March, 1880, allowed of accepting bills payable in towns of Algeria.

The new service has been working from its beginning with the greatest regularity. From the 15th June till the 31st December, 1879, 425,981 bills of exchange, &c., amounting to the sum of 9,564,298 francs, were deposited at its counters.

The sums received under this head for the profit of the Treasury amounted already to 96,616 francs, and the deductions in favour of the postmasters and postmen attained 43,494 francs. These results were easily obtained, without hesitations, without inconvenience to the general progress of the service.

Wishing to profit by the advantages of the new law, the public did not leave off demanding the extension of it; many chambers of commerce made themselves specially the organs of these wishes. We were asked to raise the maximum of the sums to be collected, and to admit protestable bills. We have not hesitated to profit by the power which gave us the 10th article of the law, and by decree of the 3rd January, 1880, and on our proposal, the maximum of sums to be collected was raised from 500 to 1,000 francs. A more recent decree of the 19th June, 1882, has raised this maximum to 2,000 francs.

We have preoccupied ourselves at the same time to allow the public to entrust also to the postal service the care of collecting protestable bills. The study of this question has made us cognisant with various systems successfully used in different countries.

The Belgian law authorises the officials of the Postal Administration in parishes where there is neither notary nor broker's man, to draw up the protests themselves; in parishes where, on the contrary, a public officer is to be found, except he be prevented or absent, the protests are drawn up by him. In the first case, moreover, the protests are not made by the postal officials unless the bill is payable in the parish itself in which the post office is situated.

The official charged to draw up the protest, merely states on the document the reasons for refusal to pay; and if the debtor has not signed, the inability or refusal to sign is stated.

In Germany, the powers of the postal officials are not so great. They have in no case the right of making the protest. When the sender forwards a bill to a post office, he may, in case the addressee should refuse to pay, request the post office to give an order to a public officer; it is sufficient to write on the back of the order the words "To protest at once," without being required, however, to designate by name the public officer. If payment does not take place, the bill is then handed over to a notary or broker's man, and this person makes the protest according to the law. If there is no public officer in the district, the post office forwards the bill to the nearest office with a request to hand it to one of the public officers of the parish.

This system is easily applied, because of the delay fixed for the drawing up of the protest by the laws of that country. In Germany the protest can be made even on the second working day which follows the day of falling due of the draft. This latter system is still in force in Switzerland, but it is contemplated to authorise the Swiss postal officials to make the protests themselves.

Neither of these two systems was immediately applicable in France. In the first one, the protest to be drawn up in certain cases by the postal officials, raised serious objections; it would have been necessary, in fact, to trust the drawing up of a document, which should present all the guarantees of authenticity, to women in charge of post offices and, above all, to letter-carriers of less than 21 years of age; this mode of procedure, moreover, clashed with our customs.

The German system, which is easily applied in countries where the time allowed for protesting is much longer than that which is fixed by our code of commerce, seemed at first sight to present certain difficulties.

The combination which we have adopted also consists of always having recourse to the intervention of a public officer, but the rules have been prepared with particular care, and have foreseen the different operations to be carried out. With the view of rendering the formality of protesting unpaid bills more easy in all districts, the Keeper of the Seals, whose co-operation we naturally had to request, proposed, in the beginning, to extend for all bills the delay of 24 hours fixed by Article 162 of the Code of Commerce.

However, after mature reflection, it has appeared preferable in this question not to introduce any modification in the existing laws. We have been able, moreover, by making use, when necessary, of the express, to assure the protest of unpaid bills at nearly all points of the territory, except in Algeria and in some islands along the coast, where the protest of unpaid bills could not take place within the legal delay of 24 hours after the falling due; moreover, the greater part of the districts which have remained outside the new service, are destitute of all commerce, and it is only very rarely that there are bills to recover, much less to protest against.

The service of the collecting of protestable bills has been inaugurated on the 1st February, 1884, in the chief towns of districts of Algeria, where there are at the same time a post office and a broker's man.

The law on the collecting of protestable bills came into force since the 1st July, 1881. A regulation of Public Administration, dated the 6th February, 1881, has fixed the rules to be followed between the public and the Administration or between the public and the officers charged with the carrying out of the protest. 3,172 broker's men and 421 notaries have agreed to execute the protests without previous deposits; so that the protest is made sure of in this manner in 20,000 parishes. In all the other parishes it can be done with previous deposit. Under these conditions we thought the time had arrived to complete the improvements introduced in the service of the collecting of bills, by reducing the rate.

The law of the 5th April, 1879, had fixed at the uniform rate of one per cent., the rates to be charged for changing the amount received into a post office order. The costs resulting therefrom were very small when they referred to sums of a relatively small amount—they often were less than the commission which a banker would have charged, and did not even amount to the rates adopted by Switzerland and Germany. But when the total amount of the bill to be collected amounted to a relatively important sum, the collecting rate became too high. We have been able to ascertain that the greater portion of the amounts entrusted to the post were less than 50 francs, and that the number of those which exceeded this sum was relatively small.

On our suggestion, therefore, the law of the 17th July, 1880, on the collecting of protestable bills has reduced to half per cent. for those exceeding 50 francs, the proportional rate for the post office orders made out in repayment of the collected bills.

The reduction of the rate fixed by the law of the 17th July, 1880, has been applied since the 1st August of that year and, far from causing a diminution in the receipts, it has augmented them to such an extent as to prove that our expectations were justified.

(To be continued.)

THE NATIONAL CONFERENCE OF ELECTRICIANS, PHILADELPHIA.

(Reported specially for the "Electrical Review.")

(Continued from page 371.)

Prof. ELIHU THOMSON: Mr. Chairman, I have been at work on dynamo machines for a long time, and my experience teaches me that some of the statements made are not correct. For example: there is a factor that has been omitted in regard to the extension of poles of magnets. We have a figure showing an extended pole piece, under which an armature is revolved. It is stated that the lines of force find it easy to go this way (arrows, fig. 5). I do not think so. We find, on examining the machine during its motion, that the armature itself is a magnet of an opposing character, that it produces poles which are opposing the magnetism of the field poles, and if the armatures are of uniform size and section throughout, that the magnetism developed here in opposition to the field of magnetism will be the same as here (indicating). Consequently, you have an opposing force to the field-magnet at this point greater than it would be there (indicating), and, consequently, you have again produced a loss of magnetic force by going this distance.

Another fact, and this is what may happen very readily, there is a field running up the side of the magnet and turning in again. By the extension of the poles, carrying your magnet along here, you will obviate to some extent that difficulty.

Then we had the statement made that one set of magnets is better than two opposing sets, as in certain well known forms of machines. I would like to take exception to that also, and for very simple reasons. Take away one magnet and you give every chance for this kind of action, and taking into consideration the fact that the armatures are crossing the magnetism of the field-magnet when it is revolving, it becomes extremely simple to see. Place another magnet here (*a*, fig. 4), and you force the magnetic lines through the armature, and you consequently have a much better machine. That leaves out of consideration the fact that

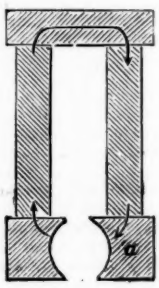


FIG. 3.

you have a small plate of material (of only two and one-half or three inches thick in case of fig. 3) in proportion to the magnet, which has enormous reaching power, if you may choose to call it so. We have an iron plate here (*a*, fig. 3). Now, taking into consideration again the enormous currents that are developed in that armature opposing the magnetism; that it passes the magnetism of the field down through the armature, you see what a

short-circuiting of the field of the armature is made when the iron plate is put in any sort of proximity to the ends of the field poles.

Again, take the form of the machine where we have the field-magnet in two pole pieces, and we bring the iron down the side to close the magnetic circuit; we bring the piece out in that manner (fig. 6). The question arises (I have not investigated the subject fully) whether the loss by magnetic short-circuit will be made up in part by the external magnetisation of the coil upon the iron in this direction (dotted lines). In other words, by removing the iron, not too far away, and again not too near,

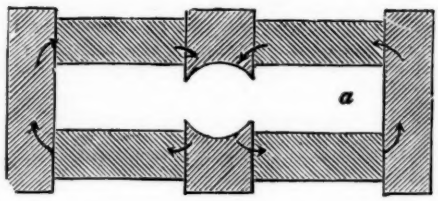


FIG. 4.

whether you do not get an external magnetisation of the iron lying close up to the exterior of the coil, which would make up for part of this loss by short-circuiting from proximity of iron to the field pole.

With regard to the use of long or short magnets in the dynamo,

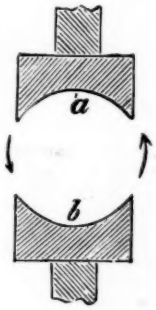


FIG. 5.

if we take into consideration what I have just stated in regard to the magnetising power of the armature, it will depend upon the diameter of the armature, and the length of the magnetic conductor that is in the armature. Assuming the armature to be made up of radial bars or even discs, the length of magnet you will have to employ will depend upon the opposing magnetic effect of the armature. And I may say also, to the distance between the field-magnet and the armature. If you wish to get reaching power or depth of field, in order to reach any distance through the armature, the iron being far away, you will have to use long magnets. If you have an armature which has long projections making an approximate contact, you can use much shorter magnets with equal results.

In regard to the use of steel magnets: It is well-known that steel in no condition can accept as much magnetism as soft iron, and it is also well known that if you harden the exterior of a magnet having soft-iron interior, that the radiation to the soft-iron interior of the magnetic lines will cause a short-circuit of magnetism through the interior of the magnet. So I do not think we can look for any improvement over soft-iron for field-magnets. There are many other considerations that might be noticed which show economy lies in using soft iron only, where we wish to get the greatest available magnetic strength.

I cannot agree with either of the gentlemen who preceded me in the statement that there is dead wire in the Gramme armature, or in any other armature that encloses a magnetic circuit. If that was the case, then all wire upon bobbins would be dead wire. We could not produce a dynamo machine which had bobbins in it (for what is the Gramme ring but a series of bobbins), which when they pass the field poles—those bobbins are magnetised there in that manner just as they are in the old Holmes and Alliance machine—when they pass from the position where they include the greatest number of lines of force, pass from the position of saturation to the position of less saturation; they go over to a position where the saturation is reversed. What suggests the reason that the outside of the wire would be more efficient than the inside wire is simply because, as I look at it, there is a tendency that is unrestrained, for the armature to kill itself while it is passing at this point (indicating). There is a tendency of the armature to magnetise the magnet, making a closed circuit on the inside of the ring, which diminishes the effect of it on this wire. However, this closing of the magnetic circuit on the outside of the core causes the field magnet to lose control of the direction of lines of force. This closure of the circuit on the inside of the ring, however, is simple and easy to take place, because here the iron is practically removed from the powerful control of the field magnet, and the coils are where they can act as magnet coils to close their own circuit. How can we increase the efficiency of such a machine? Evidently we can prevent that closure by putting some more magnetic material there.

There is an effect in such machines to which attention has not been called. It is that we can take the same sizes of wire applied to a larger machine and exhibit a real and theoretical increase of efficiency. I hold, however, that theory, when it is true and complete, always coincides with true and complete practice; there is no intermediate stopping point. If you take into consideration every variable, you are bound to arrive at the complete practice; you cannot have one thing theoretical and the other practical. It has been proved mathematically, and it is very easy to go over the ground, but I will not take your attention now, that if we use the same size of wire on armature and field we have the power of the machine increased as the fourth power of its linear dimensions. But if we attempt to apply that in practice, we find this: that the surface of the machine clearly increases as the square of the dimensions, whereas the cubic capacity—in other words, its power to retain heat—increases as the cube of its dimensions. The result of that is, that in a large machine you will have to provide a greater amount, proportionately, of cooling surface, or enlarge the size of the wire. The power of the dynamo run for series lighting (I may say I have only determined it approximately) increases as the cube instead of the fourth power of the linear dimensions.

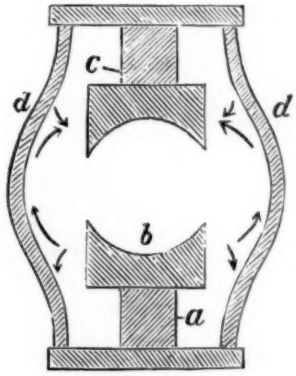


FIG. C.

In the study of the Gramme armature and its method of commutation I think we have yet to learn a great deal. I cannot see any reason why in the Gramme armature during the commutation there should be any loss at all. Let us figure the ring and study the action of commutation. A coil goes out and comes upon the commutator, passes it and returns, and so on. I hold that the period of contact is such that if the brushes upon these segments are properly arranged there will be no loss; in other words, the time of contact that must exist between these two segments and the brush will be the time that it takes for the coil to lose its current; the commutation must not occur at any other time than when the coil is ready to lose the current and acquire current in the opposite direction of the same amount it is to take when the break shall be made. I do not know that I have made that perfectly clear, but I will go over it again. If the contact remains for a sufficient period to allow the coil to lose its current and the commutation is only being made while it is running down in electromotive force, and continues until the current rises on the other side, until it is fit to go into the circuit; in other words, until it just conducts the current that the other side demands, you will have no loss from commutation. Make it just at that period, and where is there any loss?

In regard to the resistance of armature coils, I think there is an effect that is generally omitted in considering dynamo machines, and it is this—that we cannot consider the measurements of the resistance of the armature at any time as the working resistance. We cannot measure it in any position and let that be taken as the resistance of the armature coil when it is working. Why? Because in any dynamo that furnishes us continuous currents we will have this condition sometimes existing. That is, in the Gramme we have constantly two series of coils; in the Brush, two series of coils, put in multiple arc at times. If you measure the machine while not at work you take it for granted that the current when the machine is running will be equal in those two branches? Will it ever be equal in those two branches? The energy developed by that armature will depend upon whether the current divides equally for the time being. In other words, whether the ring is equally balanced, or whether the brushes are of equal temperature, or whether the armature is put at the centre of the field. The wire will become more energetic if it is nearer the field pole than the under side, and the effect will be that you are sure to displace your commutator brushes. More current will pass through one side than through the other, and you will have more heat developed in one than in the other, and you will not have a perfect dynamo. You will have more energy consumed in that dynamo; and I may say that there is not a

machine that I do not regard as coming under that condition. You measure the resistance of the machine when still, and you will not have the same resistance when running it, because the currents do not divide as in still resistance.

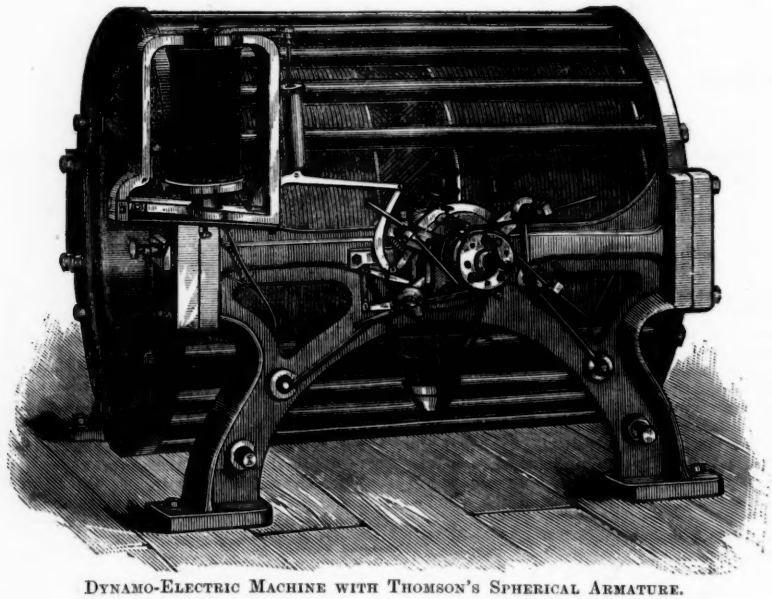
That is about all I have to say in regard to the subject under discussion, except that if I have an opportunity I should like to call attention to a number of other matters that affect the working of dynamos. These matters have been derived from studying dynamos and making very many types of machines and experimenting with them, my whole time being almost entirely devoted to their study.

THE PHILADELPHIA ELECTRICAL EXHIBITION.

THIRD NOTICE.

THE Thomson-Houston Electric Company.—The system of lighting exhibited by this company comprised dynamos, regulators, arc lamps, switches, cut-offs, incandescent lamp distributors, central station switchboards, &c., together with a number of specialities exhibited publicly for the first time at this exhibition. It will be our purpose to describe the various parts of this system, whose growth in the United States has been very rapid, there being about 10,000 arc lamps and 500 dynamos in use; while in the Canadian provinces it seems to be the only arc system that has met with much extension.

The Thomson spherical armature dynamo which was partly described in the ELEC. REV. for March 31st., 1883,



DYNAMO-ELECTRIC MACHINE WITH THOMSON'S SPHERICAL ARMATURE.

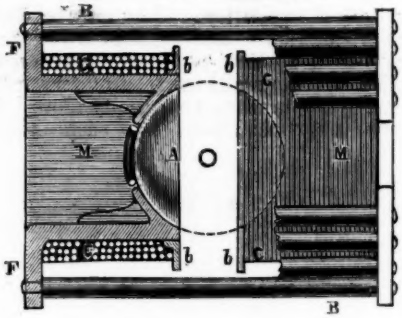
embodies some of the joint inventions of Elihu Thomson and Edwin J. Houston, and further radical improvements of Elihu Thomson. It furnishes current for the running of arc lights, lights in series and in multiple series, motors, motor-generators, and incandescent lamp distributors, giving to the line at all times a standard current due to the use of the automatic regulation peculiar to it. It is constructed of various sizes, the normal capacity varying from one arc light to sixty in series. The work of each machine may be changed from short circuit to full load, or inversely, quickly or gradually, while the line current is restored and kept to its normal standard by the automatic regulator. Variations of driving speed are, in like manner, compensated for by the regulator, provided that the speed does not fall below an amount necessary to maintain the current under any given external resistance.

The winding of the machines is varied during construction so as to adapt them to the production of the standard currents of 4·8 ampères, 6·3 ampères, 9·6 ampères, 20 ampères, 30 ampères, and above, when so ordered. The current of 9·6 ampères is the usual standard. Briefly, the machine has two field-magnet coils, which are virtually but one coil, and they are wound so as to enclose the armature core as well as the field-magnet cores. Virtually, therefore, the armature revolves inside the field coils, and its core is directly polarised by them. The form of the armature being, when wound, that of a sphere, conduces to this disposition of the field coils, which are themselves cylindrical coils. The foregoing disposition was adopted by Mr. Thomson as of value in causing the field magnetism to pass through the armature core, and as increasing the proportion of wire directly subjected to magnetic actions, while the form of armature is such as can be readily constructed and wound; gives small air resistance, good balance, and sufficient ventilation of the wire during revolution. The armature-winding is the Thomson-Houston method, involving the employment of but three coils or sections of wire, three of the terminals of which are connected together at a common joint, and the three free ends connected singly to separate segments, three in number, in the commutator. The segments are peculiarly mounted, and are removable and replaceable, as will be seen from the details of its construction. The commutator brushes are four in number, and are regulable in pairs, as will also be described.

Referring now to the figures, the field-magnets consist of two hollow iron castings, M, M, of the form shown in fig. 1, partly in section, and having flanges F, F, extending therefrom. At A they are shaped to a nearly hemispherical outline. The magnet coils, C, C, are wound upon their exteriors, and a brass flange, *b*, *b*, keeps the coils in place. The space, A, A, between the opposed faces of the castings is nearly filled by the spherical armature, the shaft of which passes transversely across, and is borne in bearings indicated in fig. 2. The bearings form part of the side frame, F^1, F^1, as shown, and to which M, M, are bolted. The large flanged portions, F, F, are united magnetically by a series of bars of soft iron, B, B, usually 18 in all, placed outside the coils, C, C, and at a short distance therefrom. The portions, F^1, F^1, besides sustaining the bearings of the shaft, are shaped as seen in the above illustration, to afford feet for the machine. In fig. 2, P is the driving pulley, D is an air jet mechanism carried concentrically with the shaft, and K, H, H, are the commutator and brushes as placed on the machine. These will be referred to in detail further on. The armature is constituted as follows:—The armature core consists of a hollow iron shell of the form of an oblate spheroid, mounted centrally upon the shaft, as seen in fig. 3, the

shaft passing through the axis of the spheroid. Two thin flange castings, *a*, *a*, are placed upon the shaft and keyed to it. They are made of fine iron, and serve to

FIG. 1.



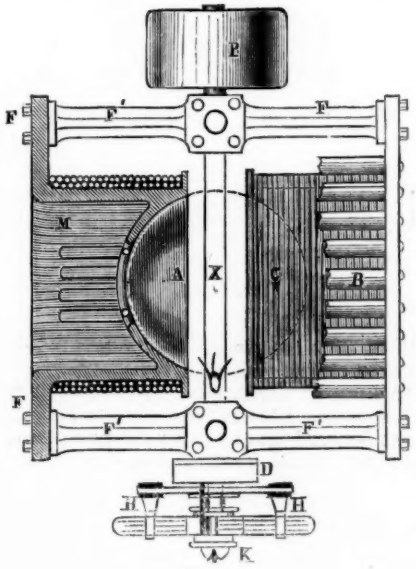


FIG. 2.

give support to a number of cast iron bridges, *d*, *d*, which are insulated from the former. There are generally 12 bridges, whose ends are carried in circular

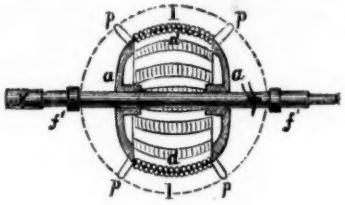


FIG. 3.

grooves in the internal rims of *a*, *a*, as shown. The width of *d* is nearly $\frac{1}{24}$ of the circumference of the flange, *a*, and figs. 4 and 5 give an idea of its usual

FIG. 4.

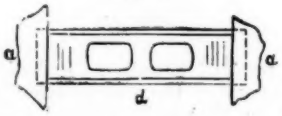


FIG. 5.

form. Outside of the bridges, *d*, *d*, is wound a quantity of well annealed soft iron wire, I, I, sealed by heat and shellaced.

The amount and depth of wire used varies with the capacity of the machine, and completes the outline of the armature core. Pins, *p*, *p*, of wood are inserted into the edge of *a*, *a*, so as to serve as guides in winding the armature. The whole core is covered with layers of insulating paper, and is then wound with the insulated wire. The pins, *p*, *p*, are so placed as to divide the circumference of the flanges, *a*, *a*, into six spaces for wire. Sometimes additional pins are placed at I, I, to correspond with those at *p*, *p*. The coils or helices of the armature are only three in number, and cross one another at the polar portions of the core, where the shaft enters. To secure electrical equality, as well as mechanical equality of the three coils or helices, the method of winding is as here stated :—

1. The first half of the first coil is wound. 2. The first half of the second coil is wound. 3. The whole of the third coil is next wound. 4. The last half of the second coil is wound. 5. The last half of the first coil finishes the winding.

The result is an approximate sphere of wire and iron. The coils are thoroughly insulated and interwoven with tapes wherever advisable to keep the wire in place. Four bands of hard brass wire, U, U, U, U, are

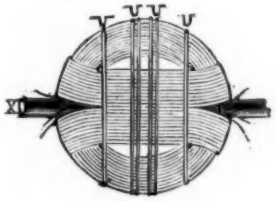


FIG. 6.

applied to the exterior, as shown in fig. 6, and hold the coils in place while revolved. As wound, the coils have six terminals, three of which are joined together, and the remaining three are carried (usually through the hollow shaft) to the separate segments of the commutator. The manner of winding is such that the three ends joined together are from the inner layers of the coils or the beginning of the winding. The coils are begun at positions 120° apart, upon the core. By this mode the highest differences of electric potential are found only upon the outside wires, such conditions being very favourable to retention of insulation under all conditions. The impulses generated in the armature correspond in the three coils at a sequence of 120° of revolution. This gives, with the small number of generating helices connected as described, a continuity of effect in the delivered currents.

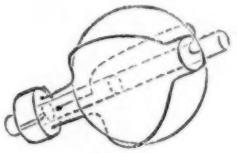


FIG. 7.

Fig. 7 shows in a diagrammatic manner the winding and connections, one half turn only of wire in each coil being figured. The commutator in the Thomson machines consists of a copper ring slit into three segments of 120° extent nearly. Each segment is independently mounted upon a metal frame which gives the segment its position.

Figs. 8 and 9 show the form of the copper segment. The piece, *e*, *e*, furnishes the means of attachment to its supporting frame, *f*, figs. 10 and 11. The segment as shown bears firmly upon *f*, at points adapted therefor. The frame, *f*, is carried in turn upon rods, *r*, *r*, upon which it is strung. The rods, *r*, *r*, are in turn mounted in insulated holes in metal flanges covered all over with hard rubber or other insulator. This construction is seen in fig. 12. The flanges are marked, *g*, *g*, and are shown in partial section, the upper half being sectioned. The rod, r^2, has a binding post for the attachment of one of the wires from the armature.

The other wires are attached in like manner to other rods, which, of course, are respectively in contact with other segments of the commutator. The mounting of

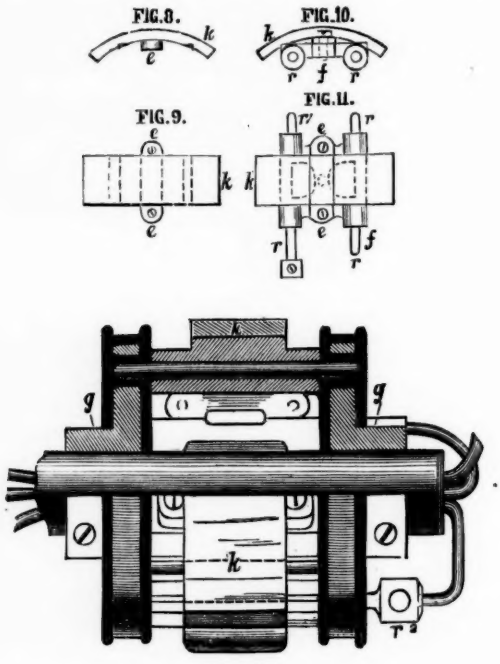


FIG. 12.

the segments thus provides a free air space all aronnd them, gives extended surfaces for insulation and nowhere does the metal of the supports approach near enough to facilitate leakage.

The fig. 13 shows diagrammatically the relation of the armature coils to the segments, and the brushes applied thereto, the field-magnet coils, C, C, and circuit, L. There are two pairs of brushes used, one pair positive, and the other negative. The brushes of each pair form angles of approximately 60°, but change their angle during regulation. The setting of the brushes is automatic, and their carriers are therefore made movable.

There are two systems of movement that will accomplish the desired regulation. They may be designated "forward regulation," and "backward regulation." Both have been applied to these machines, but the latter is that now generally used. In "forward regulation," fig. 14, the brushes are simply moved forward while retaining their relations to each other, as in

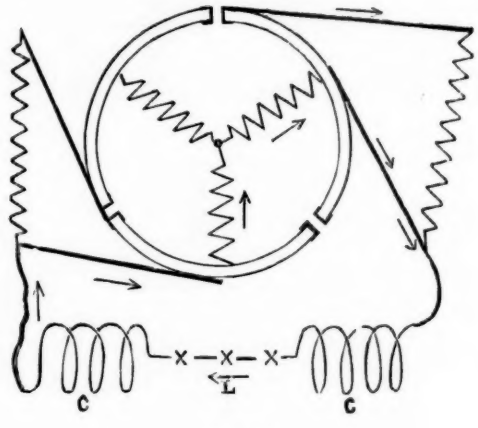


FIG. 13.

dotted lines, so as to preserve a constant current when a diminished circuit resistance takes place.

In "backward" regulation the brushes, 2, 2, fig. 15, receive a movement backwards, and the brushes, 1, 1, a movement forwards at one third the rate of movement of 2, 2, to compensate for diminished circuit resistance

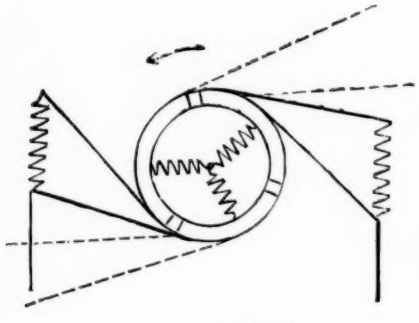


FIG. 14.

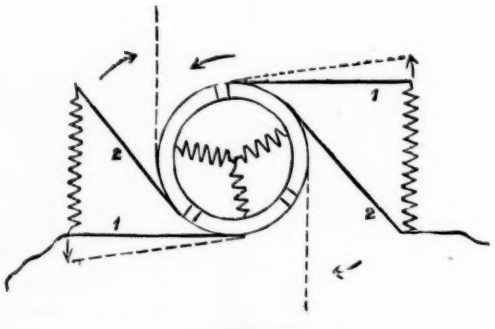


FIG. 15.

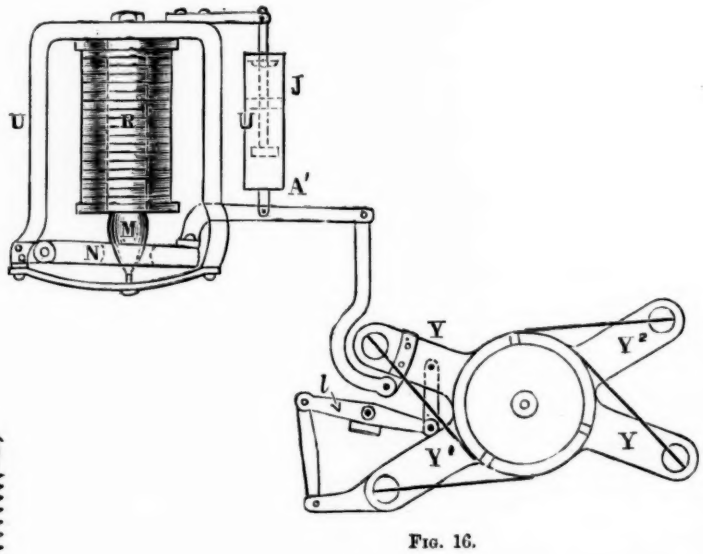


FIG. 16.

or increased speed of running. In both cases of regulation the position of the commutator and brushes is originally set so that only a small spark of rupture occurs when the segments break contact with the leading brushes. The connections of the regulator are shown in fig. 16. The motor regulator-magnet is constructed of a stout U-shaped frame carrying a coil and core, R, whose pole, M, is paraboloidal; the armature, N, has a large perforation, whose edges are rounded, moving over the pole, M; the armature is swung upon its pivots, as shown, and is situated between the legs of U, U, a construction which relieves undue strain upon the pivots,

and the armature, N, does not change its distance from the legs. A dash pot, J, checks too sudden movements. The form of magnet just described was constructed by Mr. Thomson for obtaining a uniform attraction at different positions of the armature with constant current, and has been extensively applied by him in lamp construction, and many other devices, in modified forms.

The motion of the regulator arm, A^1, is given to the yoke, Y, Y, of the commutator by a connecting link seen in the figure. The yoke, Y, Y, is made to impart movement to Y^2, Y^2, by an intermediate lever, *l*, and appropriate connecting links. The brushes are, of course, thoroughly insulated from the carrying yokes.

The regulator magnet, R, is seldom so sensitive to current fluctuations as to be used by itself for regulating the brushes. It is therefore made to respond to the action of a sensitive controller magnet placed in a suitable protecting case near the machine.

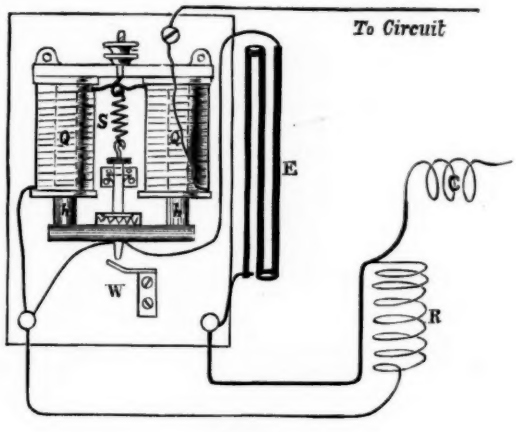


FIG. 17.

Fig. 17 shows the controller magnet as made of two hollow helices or solenoids, Q, Q, placed side by side and exerting axial attraction upon two yoked cores, *h*, *h*, suspended as shown by an adjustable spring. The weight of the cores, &c., is such that when a standard current flows the attraction will be insufficient to lift the cores, but is assisted a little by the spring. The yoke of the cores, *h*, *h*, carries a silver contact piece resting, when out of action, upon a second stationary piece, W, suitably placed below it. A resistance, E, of carbon rods is connected around the contact, and the contacts form, when closed, a shunt of small resistance around the carbon, E, and the regulator magnet coil, R. The coils, Q, Q, are permanently in circuit. Slight fluctuations of the line current are recognised by the controller so formed, when once adjusted, and a closing and opening of its contacts at W takes place in accordance therewith, the result being that the magnet, R, is shunted more or less, or for greater or less periods, and acts to maintain the commutator brushes at those positions corresponding to the standard line current to which the controller magnet has been set. The controller is virtually a delicate relay for counteracting the variations of line current by its control of the motor magnet, R. The results are, that machines can be short-circuited or their external work varied, or variations of driving speed occur, and a standard current still be maintained. Unsteady power does not injure the steadiness and uniformity of the arc lights supplied.

A striking feature of the Thomson apparatus is the air jet or blast applied to the commutator. Its purpose is to control high potential differences between the segments, and to permit the free oiling of the commutator to diminish wear. By its use machines giving over 2,500 volts from only three segments and three armature coils are successfully operated. It is well known that in high potential machines little or no oil can be applied to the commutator, and that in many cases the potentials are divided by the use of two, three, or more commutators in series.

Thomson's air blast is based upon the discovery by him of the fact that a jet of air of small amount could effectually break and disturb any line of conducting particles tending to bridge the commutator slots, and so cause discharges termed "flashing" or "arcing over the slots." Small jets, T, fig. 20, are mounted directly opposite the tips of the commutator brush of each set. When the slot in the commutator is passing the tips of the brushes a puff or jet of air enters the slot from T and effectually insulates it. The jets are repeated at every slot.

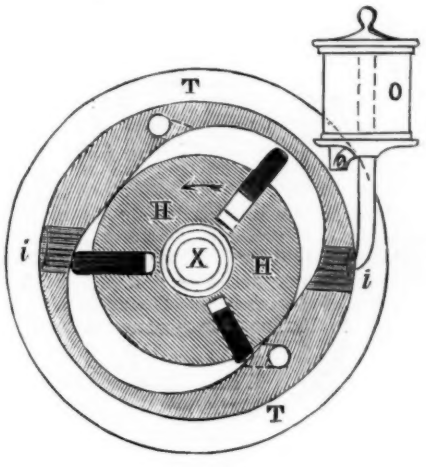


FIG. 18.

The inventor has devised a simple mechanism for furnishing the puffs at the proper instant. A small rotary positive blower, figs. 18 and 19, is mounted on the journal box at the commutator side of the machine and driven by the machine shaft, X, passing through it. The case is circular, but is bored out to a nearly elliptical outline interiorly, in which elliptical space a circular hub, H, H, is revolved by the shaft, X. The hub, H, H, is not firmly fastened to the shaft, but is merely driven loosely by a key and spline as usual in such cases.

FIG. 20.

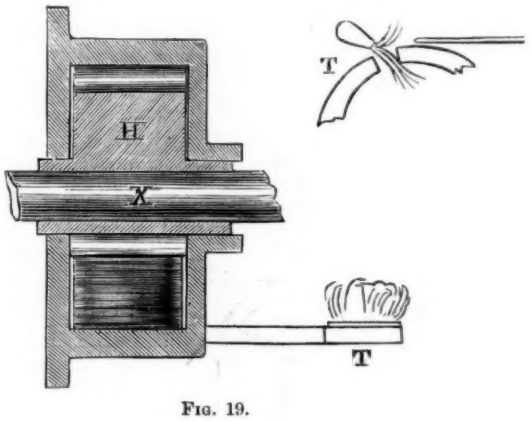


FIG. 19.

The hub is slotted as shown for the reception of three hard rubber or ebonite wings, serving as rotary pistons, and corresponding to the commutator slots in such way that they are giving their maximum action in propelling air at the moments when the commutator slots pass the brushes. During rotation air is drawn in at *i*, *i*, the inlets, consisting of numerous small perforations in the case, usually covered by wire gauge screens. The air is ejected from T, T, which

openings are in communication with those ends of the crescent-shaped piston spaces towards which the rubber pistons move. An oiler, O, is affixed as shown, and introduces small quantities of oil at *i* from time to time. In fig. 19 T shows the jet tube, the jet proper being a thin slit in the tube a little longer than the commutator segments are wide. The jets, or puffs of air, match perfectly the times of passage of the slots in the commutator, and can be made of sufficient vigour to secure perfect insulation. The wear of parts is very small, and the rubber pieces have been examined after over a year's use without disclosing any considerable wear. As a result of the use of the air blast, the Thomson machines can be effectually run with a steady stream of oil falling upon the commutator, and the segments of the commutator being mounted in *free air* without carbonisable material in contact with them, no fear of short circuits of armature coils by leaky commutators need be apprehended.

The action of the machine in developing current may be briefly described as follows:—The armature helices act for a portion of the time in multiple arc of two coils, as when traversing field spaces where the impulses generated in them are considerably below the maximum, and the third coil acts alone in series with the said two coils when producing its maximum impulse or electromotive force. The armature coil system being a three branched conductor, gives rise to the condition just stated as a necessity of its action. The mode of application of the brushes causes successive transfers from branch to branch, as they succeed each other in

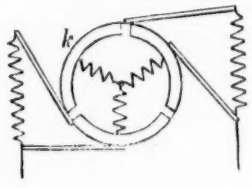


FIG. 21.

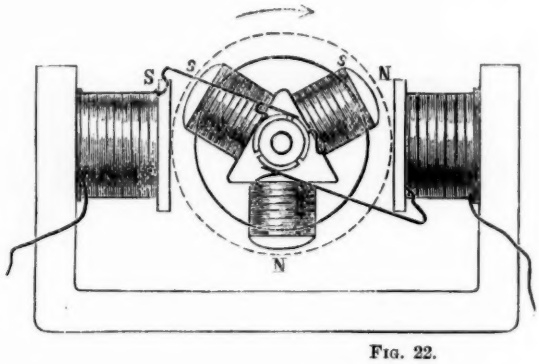


FIG. 22.

electromotive energy, or capability of feeding current to the circuit, and these transfers are effected in a time more or less definite. The segments are alternately put into contact with the positive and negative brushes. The angle between the brushes of each pair gives ample time for the transfer of current from a coil that is going out of action to the one coming into action to supplant the former. In certain of the arrangements above described for the brushes, it will be seen, fig. 15, that there exists the apparently anomalous condition of putting a commutator segment just before the coil or branch to which it is the outlet, has reached neutrality of electromotive force or electrical state, into brief contact or connection with both positive and negative brushes of the machine (see fig. 21, *k*). This condition, however, gives rise to no perceptible inconvenience, a fact accounted for by the powerful effect of the field-magnet helices in preserving the volume and direction of flow of current in the main circuit at the moment of the brief contact above referred to. During regulation, called "backward" regulation, the motion of the brushes is such as to enlarge the period of connection of positive and negative brushes and so diminish the electromotive force of the machine. At the same time, however, the total resistance in circuit having been lessened by extinction of lights or removal of resistances, while the delivered current strength is kept the same, the energy evolved in the main circuit falls in proportion, and the mechanical energy expended upon the armature falls in nearly like proportion. The following table, compiled from tests of a machine running 34 full lights, gradually diminished to a short circuit, will elucidate the matter. It is to be understood that *in practice* such a machine is rarely used with less than half its number of lights in circuit, though capable of being run indefinitely on short circuit. Thomson "M" dynamo—34 arc lights, 26·2 H.P.; 30 arc lights, 23·8 H.P.; 25 arc lights, 21·3 H.P.; 20 arc lights, 18·6 H.P.; 15 arc lights, 16·0 H.P.; 10 arc lights, 13·2 H.P.; 5 arc lights, 10·1 H.P.; 1 arc light, 6·5 H.P.; short circuit, 6·0 H.P. The power stated includes air resistance and friction of all kinds; being the total energy supplied.

In "forward" regulation, fig. 14, there are different conditions set up. The action is then analogous to that of setting the brushes of a Gramme or Siemens machine forward, and depends upon the existence of counter electromotive forces in the coils of the armature to effect an adaptation to variations of circuit resistance. Unlike the Gramme or Siemens, such setting forward of the brushes *does not* in the "three branched" system involve short circuits of active armature coils, because the time of contact of two successive segments with the positive brush, for instance, is so chosen in the original setting of the brushes, as to permit simply a transfer of current to be accomplished from a coil that is leaving, to the branch or coil that succeeds it. This transfer is not instantaneous, and varies in time inversely with the strength of the magnetism of the field magnets relative to the magnetic power and self induction of the armature coils. In either case of regulation, speed variations are compensated automatically, in virtue of the fact that increase of speed increases the current, and calls into action the regulator. The machine is also a simple and efficient *motor*. In using it for converting energy of current into mechanical energy, the arrangement of brushes is usually similar to the figure 14, but the armature connections are made suitably to cause a forward rotation. Sometimes, in simple machines used as motors and the like, single positive and negative brushes are used, and the slot between the segments of the commutator made to allow overlap to the segments, so that each segment, instead of covering 120°, extends about 160° around the commutator. Simple generators are constructed in like manner.

The *three branch* armature coil system embodied in the Thomson machines above described, has been employed by the same inventor in the winding of cylindrical and ring armatures, for generators and motors. It has also been applied to machines whose armatures consisted of six revolving bobbins, each pair of opposite coils being used as one branch from the common joint or union of the three branches. Small motors have also been made in which the armature coils were simply wound upon three radial spokes or arms projecting from a central hub upon the shaft. Fig. 22 illustrates the motor so formed.

It is evident that many forms of armature core may be adapted to use with the *three branch* winding, or the coils alone may be revolved in a magnetic-field and yield the requisite order of electrical impulses.

(*To be continued.*)

REVIEW.

Magneto-Electric and Dynamo-Electric Machines: their Construction and Practical Application to Electric Lighting and the Transmission of Power. By Dr. H. SCHELLEN. Translated from the 3rd German edition by Nathaniel S. Keith and Percy Neymann, Ph.D., with very large additions and notes relating to American machines, by Nathaniel S. Keith. Vol. I. New York: D. Van Nostrand, 23, Murray Street.

The original editions of this work were written in a popular style which the author has, under advice, to a great extent abandoned, without, however, sacrificing simplicity of demonstration. Owing to the amount of matter which had to be dealt with, the new edition has been divided into two vols., of which the one under consideration is the first. A material alteration and improvement which distinguishes the present work is the uniform adoption of the Paris Convention units. The translator throughout the work freely criticises Dr. Schellen's theories, pointing out the weak points, but he avoids substituting theories of his own. The book, generally speaking, is really little more than a recent edition of such a work as Gordon's "Treatise on Electric Lighting," though, of course, it is by no means a copy. The usual preliminary chapter dealing with magnetic induction commences the work, and calls for no comment. We next have brief descriptions of measuring instruments, both for mechanical and electrical work. The bulk of the remainder of the work is taken up with descriptions of dynamo machines, the number described being larger than that given in any other book. We notice, however, that the "Ball" machine is only mentioned as "not having yet attained any technical importance." Part XII., in which the theory of dynamo-electric machines is dealt with, the experimental and theoretical considerations of Frölich and of Marcel Deprez are given, the author himself not entering into the question. An appendix, showing the units, wire gauge, weights of wire, apparent resistance of the arc of varying length, &c., concludes the volume. Many of the illustrations are hardly satisfactory, and the practice of printing proper names in italics, capitals, and Roman letters, indiscriminately, is not to be commended. Of its kind the book may be pronounced good, but, as we before stated, it can hardly be looked upon as more than a recent edition of older works, being deficient in originality.

LEGAL.

(*Sittings in Bankruptcy, Royal Courts of Justice, before* Mr. REGISTRAR BROUGHAM.)

IN RE S. C. HADLEY.

THIS was an application by Mr. Simeon Charles Hadley, formerly an alderman of the City of London, for an order of discharge. The liabilities amounted to £21,369, and the assets, which were estimated by the bankrupt at £2,328, consisted of book debts, which would not produce the value set upon them. The official receiver had no reason to believe that the bankrupt had committed any misdemeanour under the Act. It appeared from the bankrupt's evidence already taken, that since he dissolved partnership with his brother, about three years ago, he had been engaged in several undertakings, including a contract or concession from the Portuguese Government for the exclusive right of laying submarine cables between England, the Azores, Portugal, and America, also in promoting companies. During this period the bankrupt had not kept any books of account showing what these transactions were. The official receiver also stated that the greater portion of the liabilities of the bankrupt were incurred at a time when he had no capital available to meet them, and when he must have known that his ability to pay the amount depended upon the successful result of his operations. The official receiver therefore submitted that the bankrupt had brought on his bankruptcy by rash and hazardous speculations.

The bankrupt stated that he entered into a contract with Mr. De Braam for laying submarine cables between England, the Azores, Portugal, and America. That was in December last. The purchase-money was £25,000, of which £5,000 was to be paid in cash and the remainder in shares. He had expected that the profits to be derived from the cable company would be sufficient to pay all his liabilities. The debt of the petitioning creditor, amounting to £3,500, had been incurred in reference to the promotion of the American, British, and Continental Cable Company. The money was advanced for the purposes of the company, and he received no portion of it for his own use. Notwithstanding his discharge, it was his intention to pay his debts. Before he undertook the cable contract he ascertained that a considerable profit was likely to arise from it.

Mr, Registrar Brougham said the report of the official receiver was *primâ facie* evidence of the facts, and showed that the bankrupt had engaged in rash and hazardous speculations. The explanations which the bankrupt gave, however, put the case in a more favourable light, as the contract into which he entered seemed on the face of it a beneficial contract, and he did not undertake it until he had ascertained that a large amount of profit was likely to come to him from it. He thought, however, that the failure was to a certain extent due to rash and hazardous speculations, and the discharge was liable to be suspended; but, instead of taking that course, he thought it would be of more advantage to the creditors to grant the discharge, subject to judgment being entered up against the bankrupt by consent, for the amount of the debts.

Conditional order accordingly.

(*Chancery Division, before* Mr. JUSTICE PEARSON.)

RE THE PHŒNIX ELECTRIC LIGHT AND POWER COMPANY, LIMITED.—TUCK'S CLAIM.

This case, which came on as an adjourned summons, raised the question whether the executor of the late Mr. Jabez Tuck, who traded as a printer under the title of Tuck & Co., could prove in the winding-up of the above company for a sum of £369 9s. 6d. in respect of printing done by Mr. Tuck between the 12th and 25th of May, 1882, at the order of the promoters of the company, which was incorporated upon the 17th of May, 1882. The items in Mr. Tuck's account, which were dated prior to the incorporation, amounted to about £26. The company had paid an account of Mr. Tuck's for work done after the 25th of May, but had uniformly repudiated all liability in respect of the account now in question. By the articles of association it was provided that the directors might pay out of the funds of the company all costs, charges, and expenses whatsoever incurred or to be incurred in or about the formation of the company, including therein (*inter alia*) the cost of printing and stationery, and might enter into any agreements for providing therefore upon such terms in all respects as they might deem advisable.

His Lordship said there was no reason why the company should not have the benefit of work for which some one else had agreed to pay, and he thought that in so holding he was acting in accordance with the most recent decision of the Court of Appeal. No doubt the promoters were liable up to the 17th of May, and as to the later items it was not proved that the company had authorised the printer. The claim upon the company failed.

NOTES.

Electric Lighting.—The Electrical Power Storage Company has lately carried out an installation at the residence of Mr. Phipps, architect, of 26, Mecklenburgh Square, consisting of 40 Swan lamps supplied by the E.P.S. accumulators. The dynamo is driven by a 1-H.P. Otto gas engine. The same company recently lighted the private residence, at Blackheath, of Mr. Yarrow, the well-known launch builder. We understand this company is making a speciality of temporary lighting, for which its batteries are admirably suited.

The lighting of a portion of the Bank of England by means of 160 20-candle power lamps, carried out by the Electrical Power Storage Company some 12 months back, has given every satisfaction. The installation has worked throughout without any stoppage, and the accumulators, from which the current is supplied entirely, have not been renewed in any way.

The Kinetic Engineering Company has, we are informed, received the order for the underground electric light cables for the lighting up of several of the streets in Greenock under the Provisional Order obtained by the Police Board. These cables will be of three types, namely, the main cable, consisting of 36 strands of copper wire, 1·5 millimetres in diameter; the branch main, consisting of 12 strands of 1·6 millimetres; and the leads for the lamp-posts, consisting of 1 wire of 1·2 millimetres diameter. These cables will be of the

Berthoud-Borel type, insulated with Berthoud-Borel material, and encased in a double sheathing of lead, the two sheathings being separated by a layer of gas-tar. A conductivity of 96 per cent., and an insulation resistance of 1,000 megohms per mile at the ordinary temperature, are guaranteed. The cables will not be laid in any troughs or pipes. They will be tarred, and then laid on a layer of fine sand placed in the bottom of the trench, and covered with the same to a depth of about 4 inches. A plank of wood, or layer of bricks, will be placed over the sand to indicate the presence of the cable to workmen afterwards taking up the street, and save it from injury by their tools. Large quantities of these cables have thus been laid in many of the principal continental towns, and give complete satisfaction.

In connection with the widening of Charing Cross Bridge, Mr. J. L. Beeman, having been instructed by the contractors, Messrs. Cochrane and Sons, of Westminster, to provide suitable lighting arrangements and apparatus for their works, has erected over each of the five stagings a 3,000 to 4,000-C.P. arc lamp, and six incandescent lamps, for use in the caissons about to be sunk under air pressure. The former plant, which consists of five D D Crompton lamps and a Bürgin machine, was operated on Tuesday evening, and gave the greatest satisfaction to all concerned. The 12-H.P. nominal gas engine used for sawing, &c., during the daytime, is the motive power for driving the arc light machinery. The apparatus has been so arranged that it can be moved about according to the exigencies of the work, and will be found of special use when the rivetting of the girders commences.

The Consolidated Company, of Portland, Me., using the Thomson-Houston light, has increased its lights from 40 to 149 during the past year, and will, it is said, reach 250 lights at full prices this year, dating from September 7th. The balance-sheet for the year ending on that date shows net earnings of $4,885 on a business of $16,696.

The Thomson-Houston light is in use at Montreal, Quebec, Toronto, St. John and Halifax, and preparations are being made by the Royal Electric Company to light Ottawa with it on an extensive scale, the dynamos to be run by turbines.

A rumour is given currency by the New York *Electrical Review* to the effect that litigation of the liveliest kind will soon be in progress with regard to the invention of incandescent lamps.

The members of the American Gas Light Association, meeting at Washington recently, expressed the opinion "that the electric light scare is over for the gas men." They maintain that the use of electricity for lighting has improved the gas business, as it has caused the people to demand more light.

The Promenade at Blackpool is to be lighted by electricity on Saturday, Sunday and Monday evenings during the winter months.

It is proposed to illuminate the Chicago Driving Park with 330 electric lights, hung over the track at intervals of only 20 feet.

Probably the largest installation of electric lighting on board ships has just been completed on the ss. *Umbria* by Messrs. J. D. F. Andrews & Co., of Glasgow. Mr. Andrews carefully studied every detail of the arrangement, and has supplied all the latest improvements of his various patented appurtenances and specially designed fittings. A very large space has been allotted for the electric machinery measuring 32 feet by 14 feet; this is situated on the lower deck midships, forward of the engine room. Here are placed four Brotherhood engines, two abreast, back to back, three of which have cylinders of 8 inches in diameter with 6 inch stroke, and one 6 inches in diameter by 4½ inch stroke. The small engine drives a Siemens 200 light dynamo, and the other three a 350 light dynamo each. There are 90 lights distributed in the engine room, stoke-holes, &c., the wires, conveying the current to these lamps being covered with India-rubber and a special composition for resisting sea water, and over all they are sheathed with iron wire. The joints between the branch and main wires are protected with a small "T" shaped joint box of cast-iron. Each lamp in the engine room is also fitted with a switch and fusible connection the same as in every other part of the ship. The engine room lights are divided into two circuits, each with a separate switch, and each stoke hole is also on a separate circuit. The dynamos are connected to the main switch board on the bulk head close to the engines. To this switch board also are brought the six main circuits which supply the ship. No. 1 circuit supplies the night system in which there are about 200 lights including those in the engine room and stoke holes. No. 2 circuit lights the aft portion of the ship. No. 3 lights midships. Nos. 4 and 5 supply the saloon, ladies' saloon, music room, &c., and No. 6 supplies all lights forward of the saloon. Each of the main leads is carried to a group of switches at the junction of the main and branch leads, where there is also a fusible connection. Each of these switches controls a group of about 30 lights and they are placed in boxes recessed in any convenient place, in passages generally at the foot of stairs. The main branch fusible connection which protects the wires is a small circular block of wood with a groove across it in which is laid a piece of lead wire, No. 16 B.W.G., connected at each end to a screw that projects at diametrically opposite sides of the block. The small branch wires lead to the lamps direct without the intervention of other fusible connections, but in the back block of the lamps there is a piece of No. 20 lead wire which protects the lamps and also shows in the event of a defect which lamp it is. An extremely simple switch is attached to each lamp. It consists simply of a screw severing connection to the lamp from the ship which is used as a return. In addition to the switch inside the room or in the lamp, there is also a switch of the same kind placed in the return wire in the passage, one for each state room. These switches are under the control of the steward. The holder is also of new design, although the same as those used by this company in their installation of the *Ems*, and it consists of four spring prongs formed from a brass tube, two of these grip the neck of the lamp which is made knob shaped to suit them, the other two have saucer shaped ends and press on to the small platinum eyes, brought out at the side of the neck or knob. As will be understood, one of these prongs is insulated from the rest by a small piece of wood forming the body of the holder, the insulated prong being attached to a pin passing through the centre of the wood. The holder is screwed on to the nozzle or nipple of the electric bracket, and in doing so the pin holding the insulated spring meets with the wire projected from the end of the nipple, thus making contact with the central wire fitting. 103 lights altogether are used in the lighting of the main dining saloon, 84 of which are suspended over the tables in very substantial and handsome 3-light electroliers or pendants hanging about two feet six inches from the ceiling. The remainder of the lamps are in small brackets and pendants to give light over the side seats. The lighting of the saloon is strikingly effective. Above the saloon is the music room, having 17 lights round the walls and over the piano and organ. The smoking room has also 17 lamps. The remainder of the lamps are distributed throughout the ship, 172 being in the state rooms. All the fittings are silver plated with the exception of those in the galleys, seamens' quarters, and engine room. On the upper deck just outside the engine room is a cast-iron box containing two switches and connecting terminals for the arc lamps. These lamps are of the same design and construction as those mentioned in our issue of May 16th, adapted to a mast head light on board ss. *Ems*. The lamp is of great simplicity, and is very suitable for the use of those not well conversant with electrical matters. In this case the lamp is arranged with double carbons. Everything in connection with the installation, including the silver plating, has been manufactured by the firm at Woodside Electric Works,

except the dynamo machines, engines, and Swan lamps. The time occupied over the installation has been a little over two months.

In referring to the above-mentioned firm we may mention that it has recently combined with its previous business that of telegraph engineers, and has secured the services of Mr. Alfred Slatter, formerly with Messrs. Clark, Muirhead & Co., as manager.

During the coming exhibition at the Alexandria Palace, we are told, the building and grounds will be brilliantly illuminated with the electric light.

Alleged Further Telephone Infringements.—Writs have been issued by the Bell Telephone Company against the Telephone Manufacturing Company, of Toronto, and the Dominion Telephone Company, for injunctions against infringement of the Bell Company's patents, by selling and using telephones similar to those patented, and for damages.

The Telephone in Spain.—The Spanish technical journals severely criticise the royal decree on the subject of the establishment of telephone systems in Spain. They prefer to see the enterprise in the hands of private companies, while the State has taken the business as a source of pecuniary profit. The price of subscription is said to be too high, and objection is made to the claim of the State to know all that is said on the subscribers' lines.

Fire Alarm Telephones in Canada.—The installation of the Fire Department telephone system at Montreal has been completed. It appears, however, that the apparatus will only be used for communications between the different stations, and will not be placed at the disposition of the public for giving alarms of fire.

Telephony in France.—Rheims is said to be the best telephonically-served town in France for its size, as it contains 210 subscribers, a proportion of 23 out of every 10,000 inhabitants. Paris, Bordeaux, and Lyons have only 14 to every 10,000.

Spanish National Submarine Telegraph Company's Cables.—The Silvertown Company informs us that it has received a telegram from Mr. Robert Kaye Gray, its engineer-in-chief, announcing the completion on Wednesday, the 5th inst., of the Las Palmas (Gran Canary), Arrecife (Lanzarote) section of the Spanish National cables. The *Silvertown* sailed from Greenhithe on Friday, the 24th ult., and arrived at Gran Canary on Monday, the 3rd inst., after having landed and buoyed the Lanzarote shore end near Arrecife, and taken the necessary soundings from thence, towards Gran Canary. Leaving again on the 4th inst. she landed the shore end near Las Palmas, and completed the cable on the following day. She then sailed from Arrecife for Santa Cruz de Teneriffe, where she arrived on Sunday, the 9th inst. The s.s. *International*, after having thoroughly sounded the projected route between Teneriffe and Senegal, also arrived at Santa Cruz on the 9th inst., and reports an excellent bottom for the proposed cable.

The Bennett-Mackay Cables.—An American contemporary hints that while the owners of the Bennett-Mackay cables will nominally hold the same rates as the other transatlantic cable companies, they will probably bid for patronage by offering a rebate to large customers.

Progress in Spain.—It is announced that the Bourse of Madrid will soon be connected by direct telegraph wires with the Bourses of all the other European capitals.

New Telegraph Station.—The Eastern Telegraph Company notifies the opening of a new station on the Island of Perim, at the mouth of the Red Sea. The rate to this place is the same as to Aden, viz., 3s. 9d. per word.

The Tasmanian Cable.—The Tasmanian submarine cable still lies silent at the bottom of the Straits, though Mr. Warren has been unremitting in his efforts to effect the necessary repairs; the weather has been too broken and the sea too rough to admit of the steamer continuing at work for a sufficiently long time together.

Economy in the Telegraph Department.—In order to economise space on the Post Office Telegraph "flimsies" for press messages, the latest order of 2,000,000 sheets has the heading, with the coat-of-arms, compressed into half-an-inch, instead of occupying about an inch and a half, as previously.

Telegraph Revenue.—The receipts from April 1st to November 8th, 1884. were £1,080,000; from April 1st to November 10th, 1883, £1,075,000.

Gas v. Electricity.—There have been periodically gathered together, says the *Mechanical World*, a large number of instances of damage by fire due, we are told, to the use of the electric light, and in consequence of this or because a fire *might* conceivably be caused thereby, certain rules and regulations were drawn up some time ago by the authorities for the prevention of any such incidents. After all this, it proves somewhat amusing and instructive to note that insurances upon the buildings in Antwerp for the Exhibition to be held there next year will be refused by the companies in case gas should be the chosen illuminant. So long as electrical engineers continue in the good habit of "pound wise and penny foolish," or in concrete terms use conductors amply large enough to avoid all possible overheating by excessive currents, there may correspondingly exist in the public mind a feeling of trust with regard to risk of fire from electric lighting. This point is of even more importance than the insertion of fusible lead wires; for in nine cases out of ten it is probable that the lamp is destroyed by excess of current before the fuse that is supposed to protect it. What would be thought of the fitter who carefully erects a governor on his engine but brings the steam to it from the boiler through a small iron gas pipe?

The Electric Lighting Act.—Major S. Flood-Page, Secretary of the Edison and Swan United Electric Light Company, Limited, has written to the President of the Board of Trade with reference to Provisional Orders for electric lighting granted under the above Act. He says that the time that has elapsed since the Orders held by the Swan and the Edison companies were transferred to the amalgamated company has enabled the directors exhaustively to study the question of central station lighting, as it is restricted under the Provisional Orders and the Electric Lighting Act of 1882, and they have reluctantly, but unanimously, arrived at the conclusion that they cannot establish a successful central lighting station in London under the Provisional Orders and the Electric Lighting Act. After stating that a deputation of directors would be glad to have an interview with the President of the Board of Trade on the subject, Major Flood Page criticises Clause 27 of the Act, providing that any authority may, within six months after the expiration of twenty-one years . . . require the undertakers to sell to it their undertaking upon terms of payment of the value of all land, buildings, works, materials, and plant, at fair market value, but without any addition in respect of compulsory purchase or goodwill, or of any profits which might have been made from the undertaking, as follows:—"As it would take, say, two years to erect the works, prepare the machinery, lay the leads, &c., our time is practically reduced to, say 19 years, at the end of which the undertakers are liable to be forcibly turned out. My directors feel that the financial result of such a provision renders it prohibitive. A large amount of capital must be spent on the installation of a central station, and the shareholders naturally expect to see a fair and reasonable return on their investment.

The undertakers, moreover, knowing that their time is short, practically 19 years, must set aside a large sinking fund so as to enable them to recover the capital, less the bare value of the buildings, &c., by the expiration of the 19 years. The profits, however, of this new industry must be, as in every novel enterprise, somewhat speculative and uncertain for several years, especially when the undertaking is weighed down under such restrictive conditions; it seems therefore more than doubtful whether a central station would be a financial success, and, this being so, the directors do not feel justified in expending the large amount of capital required. If any central station proved a success, the local authority would naturally buy it up at the earliest date, but, if it should prove unsuccessful, the local authority would as naturally leave it alone; if, moreover, during the next few years, by energy, fresh discoveries, improved appliances, or any other cause, the station should, after 19 years of comparative failure, be turned into a success, the local authority, and not the undertakers, would step in and reap the advantage. It is not possible to justify the application of a large amount of capital, amounting to from £50,000 to £200,000, to the establishment of a central station under such unfair and harassing conditions." With regard to Clause 18, which provides that the undertakers shall not be entitled in any way to control or interfere with the manner in which electricity supplied by them is used, he says that while it would be comparatively easy to calculate the amount of electricity which would be used to light a house, a shop, a club, or theatre, and provision could be made accordingly, it is not yet possible to estimate the amount of current that might be required in factories and workshops, when, as before long the electric current may be largely used as motive power, a compulsory supply for this purpose might necessitate laying fresh leads at a large and unremunerative expense. Referring to the Provisional Orders and the clauses providing that the undertakers shall lay down distributing mains for the purposes of general supply in every street, and part of a street specified, and maintain the same, with a penalty for default, he says :—"It is certain that in the present state of electrical knowledge and of electrical appliances, it will not pay the undertakers to provide buildings, supply plant, lay down leads, and manufacture electricity unless the current is used and paid for by the users for a certain average number of hours a day, and that therefore to compel the undertakers to go to this expense in order to supply a private house with electric light for an hour or two a day, in the lightest season of the year, is to render it certain that it will not pay."

The Patent Office.—In the House of Commons, on Monday, replying to Mr. J. Howard, Mr. Chamberlain said the Board of Trade had for some time past considered the question of enlarging the Library of the Patent Office. It had been decided to afford double the existing accommodation, and the work would be commenced as soon as the money was voted for the purpose. It was not intended to build a new patent office.

Proposed International Art Exhibition at Edinburgh.—It is contemplated, we learn, to hold an International Exhibition in Edinburgh, to include works illustrating art and industry from all quarters, during the summer of 1886.

Electricity without Motive Power.—The man Harrison, committed for obtaining money by false pretences at Manchester, by representing himself to be the inventor of a system of electricity which required no motive power, was on Tuesday, at the Manchester Assizes, found guilty, and sentenced by Mr. Justice Day to five years' penal servitude.

Railway Contracts.—Mr. H. Thorpe, of 55, Theobald's Road, has obtained the contract for the supply of a number of electrical sundries to the Great Western Railway Company for the ensuing year.

Exhibition at the Alexandria Palace in 1885.—An International Exhibition of arts, manufactures, scientific, agricultural, and industrial products, mechanical processes, and new inventions, is to be held, in 1885, under distinguished patronage, at the Alexandria Palace. The machinery section will include machinery in motion, steam-engines, agricultural implements, and all mechanical appliances and machinery used in all branches of manufacture. One-tenth of the entire receipts for admission are to be set apart for charitable purposes, under the control and management of a committee, of which Col. Sir Herbert Sandford has been appointed chairman.

The British Association.—The general committee of the British Association for the Advancement of Science met at the Royal Institute on Wednesday afternoon, when Sir Lyon Playfair was appointed president elect for the next meeting, which will be held at Aberdeen, commencing on Wednesday, September 9th, 1885. Invitations for 1886 were presented from Birmingham, Bournemouth, and Manchester, and after hearing the representatives of the different places, it was unanimously resolved to hold the 1886 meeting in Birmingham.

Telegraphy in Western Australia.—Amongst the items of expenditure for the new loan to the Western Australian Legislature are new post and telegraph offices at Perth, and a telegraph from Roeburne to Derby.

Another Gas Explosion.—Last Saturday, at a large warehouse in Great Winchester Street, a violent gas explosion took place, completely wrecking the counting house where it occurred. A man was severely burnt and shaken, and was taken to St. Barthomew's Hospital in a dangerous condition.

Royal Meteorological Society.—At the meeting of this society, to be held at 25, Great George Street, Westminster, on Wednesday, the 19th instant, the following papers will be read :—"On the injury by lightning (April 28th, 1884) to the monument to the first Duke of Sutherland at Lillieshall, Shropshire," by C. C. Walker; and "On the mechanical characteristics of lightning strokes," by Col. the Hon. Arthur Parnell.

New Partnership.—Mr. Alfred Thompson announces that he has taken Mr. Robert Ord Ritchie (late manager of Messrs. Woodhouse & Rawson's Installation Department) into partnership in his electrical and general engineering business, which will hereafter be carried on at 14 and 15, St. Swithin's Lane, under the style or firm of "Thompson & Richie."

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Lancashire and Cheshire Telephonic Exchange Company, Limited.—The annual return of this company, made up to the 11th of August, was filed on the 6th inst. The nominal capital is £300,000 in £1 shares, of which 296,161 have been taken up and are fully paid. As compared with the previous return, the paid-up capital shows an increase of £84. Registered office : 38, Faulkner Street, Manchester.

Pall Mall Electric Association, Limited.—The annual return of this company, made up to the 6th inst., was filed on the 7th inst. The nominal capital is £15,000 in £5 shares. 400 shares have been fully paid and 2,600 (vendors' shares) are considered as fully paid. During the year a call of £2 10s. has been made upon 400 shares. Registered office : 21, Holborn Viaduct.

Iron Primary Battery Company, Limited.—This company has entered into an agreement, dated 8th ult. and filed on the 4th inst., for taking over the interests

of Messrs. Rowland Matthews and James Noad, in the letters patent dated 14th November, 1883, No. 5371, for improvements in primary and secondary batteries for electric lighting and other purposes.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AT an ordinary general meeting of this society, held on Thursday, 13th inst., a paper "On the Theory of Alternating Currents, particularly in reference to two Alternate-Current Machines connected to the same Circuit," by J. HOPKINSON, F.R.S. (of which the following is an abstract), was read:—

"In my lecture on Electric Lighting, delivered before the Institution of Civil Engineers last year, I considered the question of two alternate-current dynamo machines connected with the same circuit, but having no rigid mechanical connection between them, and I showed that, if two such machines be coupled in series, they will tend to nullify each other's effect; if parallel, to add their effects.

"Consider two machines independently driven, so as to have approximately the same periodic time and the same electromotive force. If these two machines are to be worked together, they may be connected in one of two ways: they may be in parallel circuit with regard to the external conductor, that is, their currents may be added algebraically and sent to the external circuit; or they may be coupled in series, that is, the whole current may pass successively through the two machines, and the electromotive force of the two machines may be added, instead of their currents. The latter case is simpler. Let us consider it first. I am going to show that if you couple two such alternate current machines in series, they will so control each other's phase as to nullify each other, and that you will get no effect from them; and, as a corollary from that, I am going to show that if you couple them in parallel circuit, they will work perfectly well together, and the currents they produce will be added; in fact, that you cannot drive alternate-current machines tandem, but that you may drive them as a pair, or, indeed, any number abreast. Now, if the machines are coupled in series, the resultant electromotive force on the circuit will be the sum of the electromotive forces of the two machines. The work done in any machine is represented by the sum of the products of the currents and of the electromotive forces, and it is clear that as the phase of the current is more near to the phase of the lagging machine than to that of the leading machine, the lagging machine must do more work in producing electricity than the leading machine; consequently its velocity will be retarded, and its retardation will go on until the two machines settle down into exactly opposite phases, when no current will pass. The moral, therefore, is, do not attempt to couple two independently driven alternate-current machines in series. Let A B represent the two terminals of an alternate-current machine; *a b* the two terminals of another machine independently driven. Let A and *a* be connected together, and B and *b*. So regarded, the two machines are in series, and we have just proved that they will exactly oppose each other's effects—that is, when A is positive, *a* will be positive also; when A is negative, *a* is also negative. Now, connecting A and *a* through the comparatively high resistance of the external circuit with B and *b*, the current passing through that circuit will not much disturb, if at all, the relations of the two machines. Hence, when A is positive, *a* will be positive, and when A is negative, *a* will be negative also; precisely the condition required that the two machines may work together to send a current into the external circuit. You may therefore, with confidence, attempt to run alternate-current machines in parallel circuit for the purpose of producing any external effect. I might easily show that the same applies to a larger number: hence, there is no more difficulty in feeding a system of conductors from a number of alternate-current machines than there is in feeding it from a number of continuous-current machines. A little care only is required that the machine shall be thrown in when it has attained something like its proper velocity. A further corollary is that alternate currents with alternate-current machines as motors may theoretically be used for the transmission of power."*

Dr. Hopkinson then proved mathematically that—

"I. If two alternate-current machines, equal in all respects, are connected in series and independently driven at the same speed, then the leading machine may actually become a motor and do mechanical work, although its electromotive force is precisely equal to that of the following machine.

"II. If two machines are coupled parallel and connected to an external circuit resistance, then the leading machine does most work in all cases.

"III. If we suppose the terminals of an alternate-current machine to be connected to a pair of conductors, the difference of potential between which is completely controlled by connection with other alternate-current machines, then the machine may act as a motor even though its electromotive force be greater than that of the system.

"IV. In the case of an alternate current through an electric arc, if we assume that there is in the arc a constant electromotive force, A, always opposed to the current, except when the current ceases, and that then its value is zero, and that E is the electromotive force of the machine, then

$$A = E \times 0{\cdot}538;$$

or, roughly, we may say that, in order that the current may not cease for a finite time, E must be at least double of A; A will of course depend upon the length of the arc.

"The work done in the arc will be proportional to the arithmetical mean value of the current taken without regard to sign. This is of course quite a different thing from the mean current as measured by an electro-dynamometer. Taking a fairly practical case, assume $A = \frac{2}{5} E$, we then find that the work done estimated by an electro-dynamometer is nearly $\frac{1}{3}$ part too much. This will suffice to show that the matter is not a mere theoretical refinement. Another erroneous method of estimating the power developed in an arc is, to replace by a resistance and adjust this resistance till the current, as measured by an electro-dynamometer, is the same as with the arc, and assume that the work done in the resistance is the same as the work done in the arc. To obtain a maximum effect from a machine, we must have $E = \pi A$. When the resistance of the circuit is taken into account, this result will be modified. It suffices to prove that it is desirable that the potential of the machine should be materially in excess of that required to maintain the arc. In all that precedes it is assumed, not only that the coefficient of self induction of each machine is constant, but that the copper conductor of the armature is the only conductor moving in the field. If there be iron cores in the armature, we shall approximate to the effect by regarding such cores as a second conducting circuit."

In considering the question of "Secondary Generators," the author stated that "When the secondary is short-circuited a *lower* electromotive force of the generating circuit is required than when it is on open circuit. In induction coils the electrostatic capacity of the coils themselves has important effects. An illustration of the effect of electrostatic induction is found in the old-fashioned Ruhmkorff coils. These were not wound symmetrically, but in such wise that one end of the secondary coil was on the whole towards the inside, the other towards the outside of the bobbin. In such coils a spark to earth may be obtained from the outside end, but not from the inside. The reason is that the outer convolutions have smaller electrostatic capacity than the inner ones. The terminals may be made to give equal sparks by the simple expedient of laying a piece of tinfoil around the whole coil and connecting it to earth.

"Some time ago Dr. Muirhead told me that he had observed that the effect of an alternate-current machine could be increased by connecting it to a condenser. This is not difficult to explain; it is a case of resonance analogous to those which are so familiar in the theory of sound and in many other branches of physics.

"Some attempts have been made to verify the proposition that two alternate-current machines can be advantageously connected parallel, but I believe, till recently, without success. I had no convenient opportunity for testing the point myself till last summer, when I had two machines of De Meritens, intended for the lighthouse of Tino,* in my hands. I have made no determinations of the constants of these machines, but between three and four years ago I thoroughly tested a pair of similar machines, now in use at a lighthouse in New South Wales.* Each machine has five rings of sixteen sections, and 40 permanent magnets. The resistance of the whole machine as connected for lighthouse work (a single arc) was 0·0313, its electromotive force (E) when running 830 revolutions per minute, 95 volts. It was further remarked that the loss of power was east with a maximum load, as is shown in the following table:—

Power applied as measured in belt	3·1,	4·8,	5·6,	6·5,	5·4
Electric power developed... ...	0·7,	3·4,	4·3,	5·7,	3·4
Mean current in ampères ...	7·7,	38·6,	51·7,	73·6,	151 (?)

"Last summer the two machines for Tino were driven from the same countershaft by link bands, at a speed of 850 to 900 revolutions per minute; the pulleys on the countershaft were sensibly equal in diameter, but those on the machines differed by rather more than a millimètre, one being 300, the other 299 mm. in diameter (about); thus the two machines had not when unconnected exactly the same speed. The pulleys have since been equalised. The bands were of course put on as slack as practicable, but no special appliance for adjusting the tightness of the bands was used. The experiment succeeded perfectly at the very first attempt. The two machines, being at rest, were coupled in series with a pilot incandescent lamp across the terminals; the two bands were then simultaneously thrown on; for some seconds the machines almost pulled up the engine. As the speed began to increase, the lamp lit up intermittently but in a few seconds more the machines dropped into step together, and the pilot lamp lit up to full brightness and became perfectly steady and remained so. An arc lamp was then introduced, and a perfectly steady current of over 200 ampères drawn off without disturbing the harmony. The arc lamp being removed, a Siemens electro-dynamometer was introduced between the machines, and it was found that the current passing was only 18 ampères, whereas, if

* "Of course, in applying these conclusions, it is necessary to remember that the machines only *tend* to control each other, and that the control of the motive power may be predominant, and *compel* the two or more machines to run at different speeds."

* The engines, dynamos, lamps, optical apparatus, and lanterns of both these lighthouses have been supplied by Messrs. Chance Bros. & Co.

the machines had been in phase to send the current in the same direction, it would have been more than ten times as great. On throwing off the two bands simultaneously, the machines continued to run by their own momentum, with retarded velocity. It was observed that the current, instead of diminishing from diminished electromotive force, steadily increased to about 50 ampères, owing to the diminished electrical control between the machines, and then dropped off to zero as the machines stopped. With De Meritens' machines, I regard coupling two or more machines parallel as practically the best way of obtaining exceptionally great currents when required in a lighthouse for penetrating a thick atmosphere."

CITY NOTES, REPORTS, MEETINGS, &c.

Edison and Swan United Electric Light Company, Limited.

A MEETING of the shareholders of the Swan and of the Edison Electric Light Companies was held at the Cannon Street Hotel on Tuesday. The meeting was convened by the directors of the Swan and Edison United Company for the purpose of explaining the present position of affairs. Mr. J. Staat Forbes presided.

The Chairman said he would relieve the secretary of the ordinary duty of reading the notice calling the meeting, as it was very necessary they should know precisely what this meeting was. It was not in any sense a legal meeting; it was more in the nature of an invitation on the part of the directors of the new company to the separate members of the old companies, in order that they might learn the position of the United Company on the first annual occasion that it was possible to place it before them. The legal meeting of the United Company had already been held, the accounts had been audited and submitted, and a report had been drawn; but the liability of the concern, so to speak, being vested for the time being in the hands of the directors, they thought it would be highly improper to take any decisions upon either the report or the accounts; and they therefore determined that a copy should be sent to the respective shareholders of the separate companies, and that they should be invited to come there in order to go through substantially a meeting of the United Company, with the slight drawback that any decision they might come to would not be legally binding.

A Voice: We are like ciphers, then, Mr. Chairman!

The Chairman: Oh, no.

Are we to pass the accounts, or have they been passed?

The Chairman: You will hear, in the course of the proceedings. The legal meeting has been adjourned pending this meeting.

Another Voice: Shall we have power to be present at that meeting? Shall we have any power or control over our own business?

The Chairman: I suppose in the sense that the directors are acting for you as mere trustees.

Is that all?

The Chairman: I think that is a good deal.

Then we have no voice in the matter!

The Chairman: I cannot imagine any greater guarantee of power than that the directors have invited you here to-day to express your views. The very object of this meeting is to know what the majority of the proprietors wish to have done; and if that is something which the constitution of the company enables the directors to do, I suppose they will do it. (Applause.) That being so, I shall proceed with this meeting exactly as if it were an ordinary meeting of the proprietors duly convened. Continuing, the Chairman said he had better point out the difficulties they had had, and the reason why they were not called together as shareholders in the Edison and Swan Company. It had been impossible hitherto on the part of either of the companies to distribute to individual proprietors the shares in the new company, the shares taken over *en bloc* from the two companies. The reason the Edison Company had been able to distribute its shares was, that it was necessary first that the company should be liquidated. The reason why the Swan Company was not able to distribute was that it only parted with a portion of its property; its share in the United Company represented its English patents, its foreign patents being reserved, and what it would have to do at a later period would be to see what machinery it would be necessary to cut to be its present share, so that one portion of it might represent the holding in the United Company, and the other the separate holding in the foreign patents. There were thus these difficulties in the way of distributing the shares, and the directors had to stand in the position of trustees, and until they could by proper and legal process distribute those shares to the individual shareholders in each company entitled to them they must bear that responsibility. Of course as soon as that could be done it would be; but practically they (the shareholders) were there that day with as much force as if they were there with legal power to vote, for their opinions would guide the decisions and acts of the trustees. He would therefore submit to them the first annual report of the United Company. Everybody of course was familiar with the reason why they were there, and why they were a united company. He believed both companies had had the story told them; the Swan Company certainly had, very fully, and he believed the Edison Company introduced the same sort of argument. The two companies were started one independent of the other, with two great names. Mr. Edison, with a good trade mark, so to speak, and very valuable patents, and Mr. Swan with a good trade mark, and separate and distinct patents, forming a separate and distinct company; and a good business was carried on, the companies each puffing its own business and proclaiming that the patents of the other were infringements. Litigation was threatened; but fortunately some who were connected with these companies had gone through similar experiences in other cases, and wisely counselled, instead of quarrelling or division, a fusion of interests. It was quite manifest that it was much better that two such companies as the Edison and the Swan should be combined as one property than that the funds of both should be used in litigation, and that each should be pitting itself against the other upon terms that would bring down to zero the value of the article they had to sell. This principle having been admitted, there came a great practical difficulty, increased by the fact that the business was purely speculative. The Swan Company had paid large sums for its patents, which were supposed to be invulnerable, and supposed to lead to business which by-and-bye would be of enormous value; that was the Swan theory: the Edison theory was precisely the same. After a great many suggestions, and after occupying the brains of certainly not the least able or experienced men in the City of London for some time, what was done was this: each company was presumed to have acted *bonâ-fide*, to have purchased its patents at some rational value, and to have carried on its business in a rational manner with the view of establishing that value. Having settled that principle they determined to act upon it, taking reasonable pains to see what moneys had been spent. The directors, wisely, he thought, put the matter in the hands of Mr. Wilson, of the firm of Quilter, Ball & Co., and Mr. Price, of Price, Waterhouse & Co.; each of these gentlemen set to work, and it was upon their report, after proper and full enquiry, that in the fusion of the companies the respective proportions of shares were allotted for distribution. An agreement was entered into, carrying out all the details of the fusion, determining in the most express language possible the conditions, monetary and otherwise, under which the thing was to be united, and that agreement was submitted, as it was legally bound to be, to separate meetings of both companies. The Swan Company took a larger proportion of the shares than the Edison, because, wisely or unwisely, it had spent more money. There were various considerations to be entered into, the internal life of each company, the contracts each had undertaken, &c.; and so the administration by the articles was submitted to a delegation of four directors from each company, and that board had done a great deal of useful work since. Having explained how Sir John Lubbock, who was chairman of the Edison Company, and who was to have been the chairman of the United Company, was obliged to retire from that position for private reasons, Mr. Forbes said he was generous or weak enough to take upon his shoulders the burden of the concern for a year. The other directors were Lord Anson, Mr. Leyland, Mr. Arnold White, and Mr. Bidwell of the Edison Company; and General Trevor, Mr. Villiers and Mr. Batt of the Swan. What they had now to do was to turn the whole of the business inside out to find what there was in it, eliminate the bad, keep the good, fuse the establishments and bring down the accounts into something like tangible and reliable figures; and having done that, within the prescribed legal time, to hold the first ordinary general meeting, which they had done, but at which they had deferred taking resolutions until they had had an opportunity of submitting the position to the shareholders. Now they had before them the outcrop of all their efforts and had for the first time a balance sheet and statement of accounts of the United Company, which, whatever its other qualities, he could submit to them as being reliable and verified figures, and accurately describing the position in which the company now stood. The directors report, which was then reviewed by the chairman, was as follows:

"The directors beg to report to the shareholders the position of the amalgamated company.

"The shareholders of the Edison Company, and the shareholders of the Swan Company respectively held special meetings on 2nd October, 1883, and unanimously resolved that the Edison and the Swan Companies should be amalgamated. In accordance with these resolutions, this company was registered on 26th October, 1883—just a twelvemonth ago. The statutory meeting was held on 29th January, 1884.

"It was provided in the agreement which formed the basis of the amalgamation, and which was approved by the shareholders at the special meetings above referred to, that the financial amalgamation should date from 1st July, 1883.

"The accounts herewith presented to the shareholders include the whole capital payments, as well as the working expenses incident to the obligations and contracts involved in the amalgamation up to the 30th June, 1884. They almost entirely consist of the accounts connected with the engagements entered into by the Edison Company, the Newcastle Swan Company, and the Swan United Company, before the amalgamation, and over which the directors of this company have had no control, as they were legally binding on the company.

"The board of the new company met for the first time at the end of October, 1883, but it was not until the early part of 1884 that it became possible to reorganise and unite the staff and offices of the two companies.

"The attention of the directors has been unremittingly given to the engagements which existed when they took over the business. Many of these were undertaken in the earliest days of electric lighting, when the rivalry between the Edison and the

Swan Companies was very keen, and in some instances the work appears to have been undertaken more with a view to advertising the business than to direct profit. The board have been occupied for months in sifting these obligations. They did not renew the contracts for lighting the Mansion House; Norwich; King's Cross, and Bricklayers' Arms Stations; and the only large buildings they are now under contract to light, on the basis of a fixed annual rental, are the Glasgow Post Office, Gatti's Restaurant, the Holborn Restaurant, Messrs. Gartsides' Works, and the Victoria Station. Wherever possible they have put an end to unprofitable contracts at the earliest moment they had power to do so, and have not undertaken a single new installation based upon annual rental.

"The contract for lighting Glasgow Post Office will terminate in February next, and Messrs. Gartsides in March. The rent of Messrs. Gatti's and the Holborn Restaurant may be expected to cover the expense of maintenance, so that no further loss is to be anticipated in working these contracts. The capital outlay on these works has not quite been closed.

"The central station at Holborn Viaduct, which was taken over from Mr. Edison's representatives by the Edison Company on its formation, has been a costly affair, and has caused the directors a great deal of anxiety. It was being worked at a serious annual loss, but the arrangements which existed, and the inconvenience which would have ensued to the users of the light, prevented the directors from stopping the central station immediately. They, however, closed it during the summer months, and opened it again on 1st October, on a basis which, while involving little risk to the company, will be remunerative if the whole of the power can be utilized. The customers were so satisfied with the incandescent light, that they have nearly all arranged to use the light at a fair charge, and several have increased the number of lamps.

"The works at the Victoria Station are almost complete; they have cost up to date, £17,000, and the station itself is now about being lighted.

"When the Swan United Company was formed, and agreed to purchase the Swan patents and the goodwill and business of the Newcastle Swan Company, together with the installations made by Mr. Crompton, it was believed that Mr. Swan's patents would hold good against all other patents. In the same manner the Edison Company supposed that Mr. Edison's patents gave them the virtual monopoly of electric incandescent lighting. Legal proceedings between the companies had commenced, when with the view of uniting the ownership of both patents and strengthening the company against all outsiders, and of saving the great expense of this litigation, the amalgamation was resolved upon with the unanimous approval of the shareholders of the two companies. Nothing has occurred since the amalgamation to throw doubt upon the validity of the patents of the company. An action has been commenced against Messrs. Woodhouse and Rawson which will be pressed on vigorously, and the firm has given an undertaking to the Court of Chancery to keep an account of the lamps manufactured and sold by them.

"The financial result of the position which the new company has inherited, is fully shown on the accompanying balance sheet. This shows that the capital account of the company stands at £353,478 which includes £85,695 issued in fully paid up shares, and that the assets of the company consist of about £75,000 representing stock, buildings, cash, book debts, installations, &c., a considerable amount of plant; an excellent lamp manufactory and business, which was established by the Swan Company; together with the Edison and the Swan patents.

"The working expenses of the company's business have been unduly large owing to the necessity of continuing for a time the cost of three sets of offices in London, the salaries of those employed in both companies, some of whom were under engagements, and by other causes inseparable from the state of things existing before the amalgamation of the two companies.

"The shareholders will be naturally anxious to know the opinion of the board as to the hope of a profitable business in the future. On this important question the directors do not wish to excite hopes that may not be realized. So long as unremunerative contracts exist, and expenses which they connot control have to be provided for, there must be a certain amount of doubt. Yet they feel satisfied that there is reasonable ground for expecting that a profitable business may be established.

"The lamp factory at Newcastle is in good working condition, and orders for lamps have largely increased, and are increasing beyond all expectations. Experiments are being made with the Edison-Hopkinson dynamo which lead to the belief that it will prove the most efficient and cheapest first-class dynamo in the market, while Mr. Edison has made such improvement in his dynamos as have increased their efficiency, and the price has been greatly reduced.

"One of the most difficult questions which have engaged the attention of the directors has been that of the provisional orders, and, as every shareholder is interested in this matter, they think the best course is to send with this report a copy of a letter which they addressed in the current month to the president of the Board of Trade.

"The scientific world thought, in 1878, that the subdivision of electric light for domestic purposes was impossible. But the great discoveries of Mr. Edison in the United States, and Mr. Swan in England, led to the conclusion that the commercial as well as the scientific problem of public electric lighting from a central station had been solved. We now know, however, that it is impossible to make a central station in London pay, unless the company is relieved from the vexatious restrictions of the Electric Lighting Act, under the provisions of which central stations can alone be legally established. As not a single London Provisional Order is being carried out, it seems reasonable to suppose that Parliament may relax its prohibitive restrictions; in which case, the directors would avail themselves of any opportunity that might offer for the establishment of a central station on a remunerative basis; they do not regard central station lighting as abandoned, but they look upon the Electric Lighting Act of 1882 as unworkable, and they await a fair and just measure which will enable them to establish central station lighting, for the benefit alike of the shareholders and the public.

"The books have been balanced to the 30th September, as may be seen by the accounts which accompany this report, and the serious loss attending past work has disapppeared.

"In conclusion, the directors assure the shareholders that no effort has been spared on their part to place the company on a sound commercial basis. Much of the time of the staff is taken up by the preparation of estimates and tenders for lighting. There are companies and firms who tender at prices which cannot be remunerative if the work is properly carried out, but this company has never sent in any estimate, whether for land or shipping installations, in which provision has not been made for the work to be performed thoroughly well, and yet leave a fair profit to the company. Their tenders are frequently passed over because others are lower, but there can be no more suicidal policy than to offer to carry out electric installations at a price which cannot possibly pay, if the work is well done. As a matter of fact, every contract or installation which has been tendered for and carried out by the Edison and Swan Company, has resulted in a trading profit to the company."

A balance sheet and profit and loss account for the year to June 30th accompanied the report, and there was also issued a profit and loss account for the three months ending September 30th, which follows:—

Dr.	£	s.	d.
To stock on 1st July, 1884	13,943	4	8
„ wages purchases and manufacturing charges ...	4,918	0	9
„ cost of installations, maintenance, wages, and materials	8,536	15	9
„ salaries, rent, office expenses, &c.	3,384	11	8
„ depreciation on plant, &c.	409	5	10
„ balance—being profit for the three months ...	752	11	7
	£31,944	10	3

Cr.	£	s.	d.
By sales of lamps, fittings, &c.	10,868	13	7
„ sales of installations, lighting, rents, &c. ...	9,046	10	11
„ interest and discount	75	17	7
„ stock on 30th September, 1884	11,953	8	2
	£31,944	10	3

In explaining the balance sheet, the Chairman alluded to the expense and the difficulties they had had to meet in educating the public to the use of the electric light. Including the item of depreciation, £2,130, the loss on the year's working had been £28,214. They had had, roughly, £300,000 locked up, to represent which they had their patents, a first-rate manufactory, and a trained establishment. He was not particularly anxious to devote his time and money to developing a thing which he believed to be bad. He might tell them that they had reasonable ground for believing that some of the largest proprietors, notwithstanding the outcrop so far, did not take a desponding view of the position. In fact they had turned the corner, as they would see by the profit and loss account for the quarter passed. They had paid the enormous sum of £300,000 in the acquisition and manifestation of the electric patents which they possessed, and now, of course, those patents were being infringed; that was a natural consequence. They had of course resorted to legal proceedings and in these they were much strengthened by the fusion of the companies. The position was very much that which the telephone had occupied, and the results of the amalgamation of interests in that instance were well known to them. The most active infringers of the Swan and Edison patents were Messrs. Woodhouse and Rawson, two young men, and possessing all the enthusiasm of youth; he did not know whether they were using their own money or other peoples', but at any rate they were enthusiastic. The Court of Chancery had made them give an undertaking to keep an account of the lamps they sold, and if this company succeeded in establishing its case, Messrs Woodhouse and Rawson would have to cash up. As to the sort of business the company was going to do, as far as the directors were concerned, it would not go into any more speculative business; they meant to put the risk on the shoulders of the customers, and not carry on any installations on the rental principle. This brought him to the public installations and the Provisional Orders. The Board of Trade engaged itself with an elaborate system to utilise the electric light in the interests of the public; it was likely to become such a tremendous monopoly, and people who put their money in it were likely to receive such enormous emoluments that it was to be tied up, and the public, unable to take care of itself, was nursed and pampered in every way by the Electric Lighting Act. They had a great many misgivings of being able to work under this Act, but it would not do to be left out in the cold, so they obtained a Provisional Order, and having got it they knew now exactly what it was worth—nothing. The provisions of the

Electric Lighting Act had made public lighting impossible, and they were not going to enter upon any business of this kind. They were not going to buy any more inventions, nor run the kind of risk involved in street lighting or house-to-house lighting, or anything but that which would pay. With this general principle before them, the conviction of the directors was that, notwithstanding that their shares had no value and the difficulties that faced them, there was reasonable ground for believing that, prudently managed, the company might retrieve itself and present a very good future. A good deal would turn on the establishment of the patents, but even setting them aside, with the names of Edison and Swan behind them they ought to do better than any competitor. According to the articles of association, the directors retired *en bloc*. He dared say they were all willing to retire if that were the pleasure of the proprietors, but as honourable men, having assumed the responsibility of conducting the company so far, they had enough self-respect to be quite willing —some of them at great personal sacrifice of time and labour—to go on and see if it be not possible to put the business on a sound basis. He had no resolution to move, but he should like to put it before them that the report and accounts be received. The moral effect of this would be exactly the same as the legal effect. (Applause.)

Lord Anson said, after the elaborate statement made by Mr. Forbes, it was unnecessary for him to make many remarks. He thoroughly agreed with all the chairman had said as to the causes of the great loss shown on last year's trading, and also as to the possibility, and even probability, of this concern being turned into a more profitable one. It would be a great mistake if they now made up their minds to stop the company altogether. If they could only hold their own for a very short time there was a prospect of their doing very well. He believed all the Edison shareholders were aware that that company was in liquidation. They had done their very best to bring that result about. And he should like also to say how thoroughly the Edison directors appreciated the friendly way in which they had been met by the chairman and his Swan colleagues. It might have been supposed that, with the conflicting interests, there would have been some degree of friction between the representatives of the two companies; but he was happy to say that they all had but one idea, and that was to make the United Company a success.

Mr. Kempster rose to move the following resolution :—"That in the opinion of this meeting it is desirable that a committee of, say, seven shareholders, with power to add to their number, should be elected, who shall fully inform themselves as to the past working of each of the two companies prior to their amalgamation, the present position of the 'United' Company, and its prospects of successful working; also that such committee should confer with the directors, and, if deemed necessary, report to the shareholders, as to any steps considered by them advisable for placing the company upon a sound commercial basis." That resolution, he said, he moved in no unfriendly spirit to the board, but he submitted with great respect that the present position of the company was such that the shareholders had a right to obtain independent information; the only way of obtaining such information being by means of a committee appointed from their own body. He was there as a small shareholder representing other shareholders who held a large number of shares. It was quite certain that the relations between the board and the shareholders were considerably stained, and he thought there was something like a link needed, which he believed the committee would supply, to restore that confidence which it was desirable should exist between shareholders and directors, and give some new hope as to the future working of the company. It would not do for things to go on as they had been, and as they were going on now. What was more unsatisfactory than the position of that meeting? They met informally after three years, during which time they had not had a single meeting at which they had had any power whatever, and now they were told, courteously and considerately, it was true, that they could do nothing which would have any legal effect. He submitted that the shares might have been so distributed as to have given them the power to which they were entitled. They had had a long and able speech from the chairman, but there was not a particle of real information in it; nothing more than was practically common knowledge beforehand. They had had no practical details of the working of the one company or of the other, or of the amalgamated company. They wanted to know something more as to the results of their contracts; what was done with the money subscribed in the Swan Company; and many other things, which at a general meeting it was impossible to elicit, but which a committee could competently deal with. There was yet no register of the shareholders of the amalgamated company, although the company itself had been registered. He did not know, too, whether the shareholders were aware that the amalgamated company were bound to pay the costs of the liquidation of the two old companies.

The Chairman: What you are stating is not correct. So long as you confine yourself to argument we will listen, but when you give mistaken statements of fact it is necessary to prevent the shareholders being misled.

Mr. Kempster said he had read the documents a few days before, and he was under the impression that such was the case.

The Solicitor stated that the 11th clause of the agreement stipulated that the amalgamated company would only pay the costs of the liquidation of the Swan Company in the event of that company being wound up within six months, and that date had now expired.

Mr. Kempster apologised for the error into which he had fallen, but remarked that they, at any rate, had the costs of the liquidation of the Edison Company, and as shareholders in the Swan Company they still had the burden of that, so that it amounted to very nearly the same thing. There were other questions, as to the disappearance from their service of gentlemen who had received very large sums of money and who they had expected would give them valuable assistance. There were questions as to Mr. Swan's standing in the company, and as to Mr. Crompton's leaving them, and also as to whether it was not possible now to cut down the working expenses to a great extent, and to find out the value there was in the concern, and whether they could not work only the profitable part of the business so as not to incur a loss.

Mr. Sudworth seconded the resolution.

Mr. J. H. Greenhill said that from what had been said it seemed the company depended altogether upon one thing, the establishment of its patents. It was all very well to take a favourable view of the result; but suppose an unfavourable verdict were given? They would then, practically, have paid a large amount of money for nothing. He would advise them to meet the thing boldly, and simply say the money was lost. But it would be a great mistake to wind up the company, for he believed that, with due economy in the working expenses, a profitable trade could be carried on, even if they did lose the money paid for the patents, in manufacturing and selling lamps; but let the company keep to what it could legitimately perform—the manufacture of the best possible lamps at the lowest possible price. He hoped that if the result of the actions pending should be in their favour it would not cause them to raise the price of the lamps to the public.

Mr. Tipping protested against the adoption of that miserable and fussy expedient—a committee of shareholders. If they wished to put a company which was a little "touchy" on its last legs, the appointment of a committee would do it. He had had some experience of committees, and opposed the resolution most strongly.

Another shareholder entirely agreed with what was said by the speaker, and warned the shareholders against adopting a suicidal policy by entrusting their property to a committee who could not possibly know the business so well as the directors.

Sir John Lubbock said he thought the absence of any check upon the action of the directors was rather imaginary than real, for knowing the gentlemen on the board as he did, he was quite sure the wishes of the shareholders would be observed. He hoped they would hesitate before agreeing to the appointment of a committee. He did not take by any means so hopeless a view of this concern as some apparently did. They had no doubt paid largely for the patents, but at the same time he saw nothing to lead them to doubt that they were of considerable value; and they must remember that the company had been working hitherto without the full advantage of its patents, as these had been infringed. It was a very doubtful expedient to adopt to appoint a committee; he liked to know upon what shoulders the responsibility rested. They had a board of directors whose honesty was undoubted, and he thought the affairs of the company should be left to them and not be put into the hands of a few shareholders of whose motives they knew nothing, and who knew nothing at all of the business. A committee of gentlemen unacquainted with electrical matters would be of no use, and he asked them if it was desirable to let them have free access to the inner working of the company if they were acquainted with the technical parts of the business.

Mr. Stevenson, M.P., also deprecated strongly the proposal to appoint a committee.

Mr. Kempster said after the discussion which had taken place, he thought he should best consult the feelings of the shareholders by withdrawing his resolution, as it seemed to be the opinion that after the elaborate statement of the Chairman it would not be advantageous to appoint a committee at the present stage. He would only say that the friends who had been conferring with him would still continue to do so, probably, so that they might have some means of working together.

The Chairman expressed his pleasure that Mr. Kempster had withdrawn his resolution, as he should have felt it his duty to oppose it tooth and nail. Probably no one had had more experience of committees of shareholders than he, and of all the machines for ruining a company, he was of opinion that that was the most effective.

After a little further desultory conversation,

Sir John Lubbock moved a vote of thanks to the Chairman, which was unanimously carried, whereupon the meeting terminated.

Edison's Indian and Colonial Electric Company, Limited.—A petition is pending for confirmation of a special resolution reducing the capital of the company from £250,000 to £117,500. The list of creditors is to be made out as for February 28th, 1885.

French Electrical Power Storage Company, Limited.—Mr. Arthur Cooper, of the firm of Cooper Brothers & Co., has been appointed by Vice-Chancellor Bacon official liquidator of this company.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 7th, were £3,034; after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1884.

14601. "Dynamo-electric machines for plating and depositing metals." G. F. CHUTTER. Dated November 5.

14649. "Telephonic apparatus." J. STEPHEN. Dated November 6.

14652. "Telephonic apparatus." J. STEPHEN. Dated November 6.

14655. "Simultaneous use of voltaic and induced electric currents in systems of telephonic intercommunication." F. TREMAIN, A. PIKE. Dated November 6.

14673. "Covering electrical conductors with plastic materials." G. C. TAYLOE, E. T. TRUMAN. Dated November 6.

14693. "Apparatus for automatic registration of numerals by electricity." C. FORD. Dated November 7.

14723. "Electric generators." Hon. C. A. PARSONS. Dated November 7.

14767. "Driving and steering mechanism for common road vehicles to facilitate their propulsion by means of electric accumulators, &c. H. J. HADDAN. (Communicated by D. Barnier.)

14779. "Dynamo-electric machines." W. R. LAKE. (Communicated by L. Bollmann.) Dated November 8. (*Complete.*)

14818. "Current reverser." H. C. HAROLD. Dated November 10.

14829. "Dynamo-electric machines." J. H. GREENHILL. Dated November 11.

14840. "Primary batteries." R. A. LEE. Dated November 11.

14846. "Insulators." L. GUTMANN. Dated November 11.

14852. "Insulator for electric purposes." L. A. GROTH. (Communicated by J. Wolf.) Dated November 11.

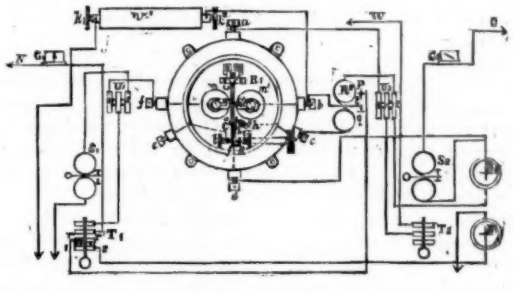
14865. "Applying electric alarums to the face of any clock." A. W. WILSON. Dated November 11.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

199. "An improvement in voltaic batteries." R. APPLEGARTH. Dated January 1. 2d. Consists in a vessel of carbon of cylindrical or any other suitable shape, grooved, fluted or corrugated inside or outside, or both and intended, while holding the exciting liquid or electrolyte, to serve also as the negative electrode, the purpose of grooving, fluting, or corrugating the carbon vessel as aforesaid, being to increase the active surface thereof in a manner similar to that described in the specification of the inventor's patent for fluted, ribbed, grooved, or corrugated carbon plates bearing date the 19th day of June, 1883, and numbered 3026. Any number of these carbon vessels may be arranged inside one another with intermediate anodes or positive elements so as to form a powerful battery in a very small space.

1709. "Improvements in accumulators or secondary batteries." E. P. ALEXANDER. (Communicated from abroad by J. L. Moisy, the younger, of Paris.) Dated January 18. 6d. According to this invention the accumulator is composed of bands or strips of lead of any suitable size and thickness cut in the form of combs. These combs are doubled or folded on themselves any desired number of times, and their ends joined together so as to present the appearance of a brush of lead. Two of these brushes placed facing each other, and separated by a sheet of gutta percha, form an element of the battery. The teeth of these brushes may be inclined or cut at any angle to facilitate the escape of the gaseous bubbles as they are produced.

2078. "An improved construction and arrangement of relay apparatus for electric telegraphs." C. D. ABEL. (Communicated from abroad by J. Kölzer, of Germany.) Dated January 24. 6d. Relates to an improved construction and arrangement of electric telegraph apparatus for transmission from line current to working current, and *vice versâ*. In order to render such a transmission possible, the polarised relay at present in use requires a different arrangement and construction from that which is employed for the simple transmission of a working current. The fig. shows this improved construction and arrangement. The armature or tongue of the polarised relay is extended and has its front end bent twice at right angles so as to form a hook, and on its extremity is a projection, *k*; this hook has for its object to limit the motion of the steel spring, *i*, and, at the same time, to conduct the electric current, arriving from o through *i* to c^1 c — w, and to affect, together with the spring, *i*, the opening and closing of the line current, o — w. On the right hand side of the armature is a small but very elastic adjustable spring, *i*, attached to the armature by means of two screws, but insulated therefrom by a plate of insulating material, *o*. This spring when at rest lies against the projection, *k*, thus making contact. On the insulating plate, *o*, at the level of the contacts, *l*, l^1, is a small stud, *j*, against which the spring, *i*, is pressed, so as not to be brought with its whole surface in contact with the plate, *o*. On the relay to the right of the armature, is a small fine wire coil, *g*, connected at one end to the spring, *i*, and at the other end to the contact screw, *h*, which is insulated from the relay, and is connected to the contact screw, *c*, also insulated from the relay. The coil, *g*, lying almost parallel with the armature of the relay, participates in the movement of the armature, without materially affecting the same. The operation of the polarised relay is sufficiently well known, and need therefore not be further described. It may, however, be stated that in regulating the same, the movable polar extensions, *n*, n^1, are not arranged equidistant from the central position of the polarised armature or tongue, c, c^1, the extension, *n*, which corresponds to the rest contact, *l*, being nearer the armature than the extension, n^1. In this case, so long as no current passes through *m*, m^1, the attraction of the north pole, *n*, for the south polarised armature, c, overbalances that of the north pole, n^1, and consequently c^1 is continually drawn towards *n*, so as to make contact at *l*; the spring, *i*, then rests upon the contact, *k*, and keeps the line circuit, o — w, closed at that point; on exciting the relay by a line current the same end is attained if the polar extensions are reversed and the battery poles are changed. The key, T^1, has a divided working contact plate, *r* and r^1, as shown. The small part to the left is connected with the contact, *p*, of the relay, R^2; on the larger part to the right is situated the working contact, and, in addition, a battery plate, *v*. The connections of the apparatus are effected as shown in the fig. R^1 is a polarised relay, R^2 a Morse relay; S^1, S^2, are writing apparatus; U^1, U^2, the two commutators; T^1, T^2, the keys; G^1, G^2, the galvanoscopes; B^1, the battery for the working current; B^2, that for the line current; W^1, a large artificial resistance, which must be greater than the total resistance of the circuit, N; o — w, the line circuit; N, the working circuit. For transmitting a message from the circuit, o — w, to the working circuit, N, or the converse, the holes, 1, are stoppered at U^1, U^2, and T^1. The course of the current in the line circuit from o to w is then as follows:—o^1, G^2, S^2, B^2, U^2, R^2, *c*, *h*, *g*, *i*, *k*, c^1, c, *a*, U^2 (over hole 1), T^2, w, &c., &c., so that the armature levers at s^2 and R^2 are attracted and lie against the rest contacts. The course of the current in the working circuit is as follows:—N, G^1, T^1, U^1 (over hole 1), f^1, *m*, m^1, *b*, K^2, through W^1 to K^1, and to earth. If now, by the depression of a key the line current is broken in the circuit, o — w, then s^2 and R^2 are out of action, the armature lever, *t*, at R^2 moves against the contact, *p*, the working current of the battery, B^1, is closed, and passes (the battery having one pole to earth) B^1, T^1 (hole 1, *r*), R^2 (by contact, *p*, armature lever, *t*), R^1 (by contact screw, *b*, wire



coils m^1, *m*, contact screw, f^1), U^1 (hole 1), T^1 (rest contact plate, body of key), G^1 to circuit wire, N, and actuates the writing apparatus at the distant station. This current must be led through the coils, m^1, *m*, of the relay, R^1, in such a direction that a south pole is produced at n^1, and a north pole at *n*, in order that the armature may be held by *n* so as to lie against the contact, *l*; the outgoing current will not take the direction to earth through *b* (K^2, K^1), because this offers too great a resistance, but will pass through the line wire, N, having a less resistance. If now the distant station of the line wire, N, sends a line current in such manner as to form at m^1 a north pole, and at *m* a south pole, then the residual north pole magnetism in n^1 will be strengthened, and the north magnetism in *n* will be neutralised, so that the attraction for n^1 to c will be the greater, and in consequence hereof, the extension of the armature, c^1, c, will be brought with the spring, *i*, against the working contact, l^1, thus closing the local circuit of battery, B^2 (through l^1, *d*, B^2, U^2, R^2, *c*, *h*, *g*, *i*), and causing the spring to be moved away from K, and thereby breaking the line circuit, o — w. If the current in the line wire, N, ceases, the armature, c^1, c, moves back again. The spring, *i*, remains so long against the contact, l^1, until it is reached by the projection, *k*, thereby closing the line circuit, o — w, and then moving away from l^1, whereby the local circuit will be opened at l^1, *i*. The armature lever of the relay, R^2, will remain against the rest contact, whereby the entrance of a current into line wire N is prevented, because the local circuit (l^1 — *i*) is closed before the line circuit (o — w) is broken. By this means, therefore, the difficulty is overcome which heretofore has rendered similar transmissions unsuitable for practical use. The connecting system of the circuit N with the circuit o — w is separated as follows:—At T^1 and commutator U^2 the stopper is moved from hole 1 to hole 2. The current of the line circuit, o — w, then passes through o, G^2, S^2, B^2, U^2 (hole 2), T^2, w, &c., &c. The armature lever, *t*, of the relay, R^2, moves away because there is no current in this part, and a permanent current would enter the circuit, N, if the stopper at T^1 were not moved from hole 1 to hole 2, whereby the battery is transferred from contact *r* to contact plate r^1. If now a station on circuit N calls, the relay, R^1, comes into action, whereby the local

current, $l^1 - i$, will be closed, the relay, R², comes into action, in this case with the property as working current. The fact that stations in circuit N calls stations in circuit O — W can therefore be ascertained, so as to effect the connections of the two circuits and to allow them to communicate. The circuit, N, is arranged for writing apparatus, S¹, by the cutting out of the two relays, R¹ and R². Should it appear necessary for any reason to separate circuit N from circuit O — W and the connecting system, and to connect it to a separate apparatus, the stopper at the commutator, U¹, is moved from hole 1 to hole 2. The connecting system is now cut out, and the writing apparatus, S¹, put in circuit. The course of the current in N is now as follows:—N, G¹, T¹, U¹ (hole 2), S¹, and to earth. The outgoing current passes, if key T¹ be depressed, through B¹, T¹ (hole 2), G¹ to N, &c., &c.; the circuit is in this case an independent one. By the above-described invention a single wire branch circuit may be established at any point of a main circuit capable of operating with the latter in the same manner as this operates in itself.

11914. "Improvements in electro-mechanical signalling apparatus and the system therefor." M. TOULMIN. Dated September 2. 6d. Relates to certain new and useful improvements in electro-mechanical railway signalling apparatus, and the system therefor, in carrying out the purpose for which it is designed, that a number of such apparatus shall be placed along a railway track, at such intervals as the natural conditions of the country through which the road passes, require.

CORRESPONDENCE.

The Telephone Patents.

I must thank F.T.H. for his long and interesting answer to my query as to transmitter diaphragms.

Though I am well aware that it is the habit of the United Telephone Company to take legal proceedings against manufacturers of telephonic apparatus, still I am not as yet acquainted with their methods of procedure in such cases, and I should, therefore, be glad if F.T.H. will give the results of his experiences in this direction.

I may mention that though to F.T.H. my suggestion as to the necessity of some surface on which to collect the sound waves in every practicable transmitter may savour of the United Telephone Company, yet I am by no means in any way interested in their defence, or prepared to admit their preposterous claims as to the exclusive right to use carbon in transmitters.

On the other hand, I must remark that according to the judicial meaning put upon the words *diaphragm* and *tympanum*, and on the expression *tympanic action*, it does not appear so very easy to make a workable instrument to clear Edison's patent as your correspondent F.T.H. seems to imagine.

Again, I fear that if he will refer to the report of "The United Telephone Co. *versus* Maclean," he will find that the great weight of evidence was on the side of the microphone working as part of a *closed* circuit, and that when a break in continuity does occur, instead of producing articulation, it destroys it.

Once more I cannot admit that a permanent magnet is "the obvious equivalent" of an electro-magnet *in the main circuit or line wire*, and an electro-magnet *in a local circuit* appears to be claimed in the patent.

I do not know, moreover, how the case may be influenced by the patents that were formerly held by the London and Globe Company, and which have now passed into the hands of the United Company.

Certainly, the claims in patent No. 676, 1883, of H. H. Eldred, appear to be for the most part either of small importance, or were repetitions of improvements advocated in the *English Mechanic* and other papers of years ago, and I cannot admit that the waterproofing of the membrane diaphragm with a coating of varnish—a claim which, by the way, is not mentioned in the provisional specification, and which cannot be considered an equivalent of a "*disc of mica or brass*"—is either novel or a fit subject for a patent at all. Still, I am not aware, though perhaps some correspondent will enlighten me, what other patents have passed to the United Company which may have any bearing on the present state of the case.

In conclusion, I would ask if any correspondent is acquainted with the reason for the *three* terminals that exist in some of the "Globe" receivers, most instruments having but two. Are there two separate coils, and what are they both for?

I fear that my contributions to this correspondence are, for the most part, a mere series of queries; but I believe that the replies that are being obtained will interest others besides myself, and will clear the way for the destruction of a monopoly.

S.

November 10th, 1884.

The Electric Lighting Act.

If your correspondent, "Ohm," will apply to me I shall be happy to furnish him with the information he requires relative to the cost of a license from the Board of Trade under the Electric Lighting Act, 1882.

The house-to-house lighting at Colchester is supplied by this company under, I think, the only license at present being worked.

Geo. Offor, *Manager,*
THE SOUTH-EASTERN ("BRUSH") ELECTRIC LIGHT AND POWER CO., LIMITED.

68A, Cow Cross Street.
London, *Nov. 8th*, 1884.

The Work that a Dynamo can Perform in terms of its Dimensions.

The following remarks are intended more as illustrative of a principle than referring to a practical law.

To fit up a dynamo installation most economically, using a dynamo of a particular type, the size of the dynamo, the resistances of the armature and field-magnet, and the velocity of revolution should be so adjusted to each other that the value of the energy realised in the exterior circuit, minus the value of the energy wasted in the dynamo and the interest upon the total cost of the installation, is a maximum.

When in a dynamo of a certain size the best value of the exterior resistance, the resistances of the armature and of the field-magnet have been found, then the proportion of these resistances to each other should be observed in other dynamos of different sizes, when producing equally efficient machines. Assuming, then, that the proportion of the resistances of the exterior circuit, the armature and the field-magnet is the same in machines of different sizes, and that the linear velocity of the armatures is constant, then the electromotive force of the different dynamos would be proportional to the length of their armature circuits, that is proportional to $\sqrt{\text{weight} \times \text{resistance}}$, so that by the aid of a constant the electromotive force of a dynamo may be expressed in terms of its weight and resistance

$$\therefore E = \sqrt{w \cdot r \cdot c}$$

where w = the weight and r the internal resistance of the dynamo, and L the exterior resistance—also, since the total work done in the circuit equals $\frac{E^2}{L + r}$ therefore the work performed by the dynamo

$$= \frac{E^2}{L + r} = w \frac{r}{L + r} c = w k$$

The electromotive force of a dynamo may therefore be defined by its weight, resistance and a constant, and its power by its weight and a constant only.

W. Moon.

CHARLES SMITH.—*Van Nostrand's Engineering Magazine* can, we think, be obtained in London of Messrs. Trübner & Co., Ludgate Hill, or of Messrs. E. & F. N. Spon & Co., Charing Cross. The *Scientific American* can be *subscribed* for through Messrs. Sampson, Low & Co., Fleet Street. We doubt if *single copies* or *back numbers* can be had in either case.—[EDS. ELEC. REV.]

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TIMES of *August 18th*.—"The lamps as finally adopted were the Woodhouse & Rawson Glow Lamps of 50 candle-power each, and these were variously arranged for the purpose of comparison as to the best method of suspension and light distribution. Some of them were placed singly and also in small clusters on poles 20 feet high, while others were suspended singly from cantilevers over the pathways and at a less height. Others, again, were suspended at a height of 20 feet above the centre of the roadway, and 100 feet apart. A current of 2 ampères was supplied to each Lamp, which takes 52 volts and 2 ampères, which equals 104 watts, and gives an efficiency of 2 *watts per candle*. This, it will be seen, is a very high efficiency, that of the Swan Lamp being stated to be 3½ watts, and that of the Edison Lamp 4 watts per candle. It is noteworthy, too, that no breakage of the Lamps adopted occurred during the trials."

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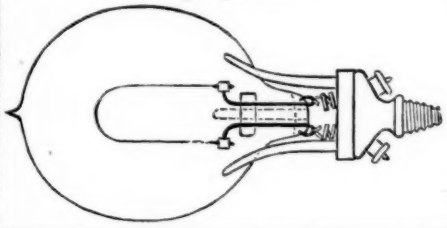

WORKS—CADBY HALL WORKS, HAMMERSMITH.

DAILY NEWS of *April 11th* on the Wimbledon Comparative Tests.—"The night before last some experiments were made with the Woodhouse & Rawson Lamps, which were regarded as very successful, and indicated an amount of efficiency that was astonishing. This enterprising firm have recently made great strides in the improvement of Incandescent Lamps."

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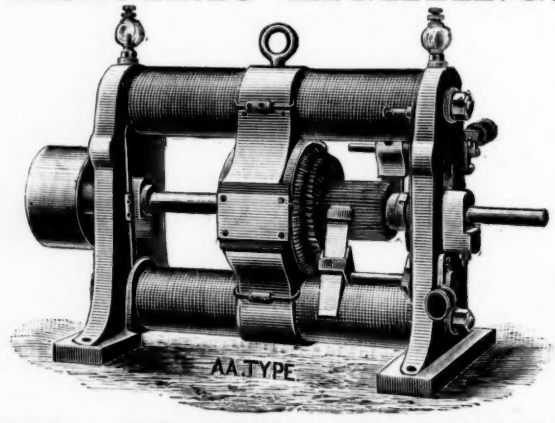

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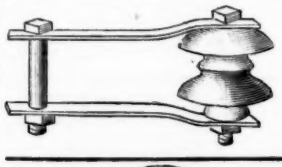

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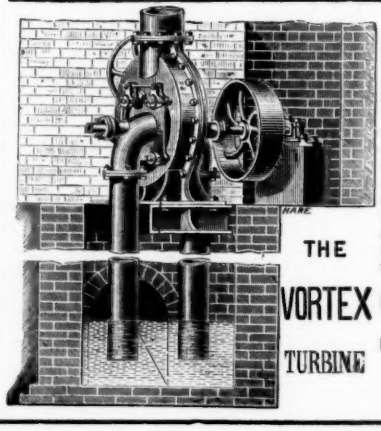

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